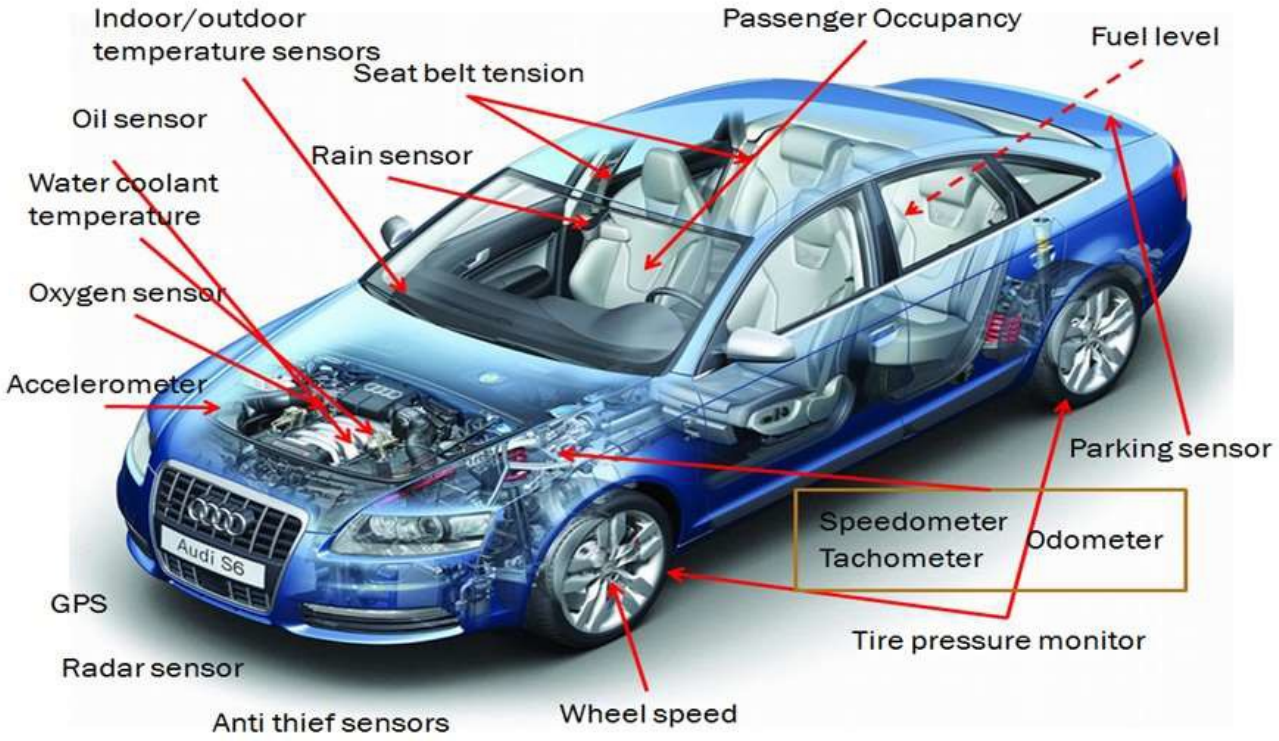
Automotive Electronics



- **Prepared BY : JDK**

Automotive Electronics

•**Automotive electronics** are any electrically-generated systems used in road vehicles.

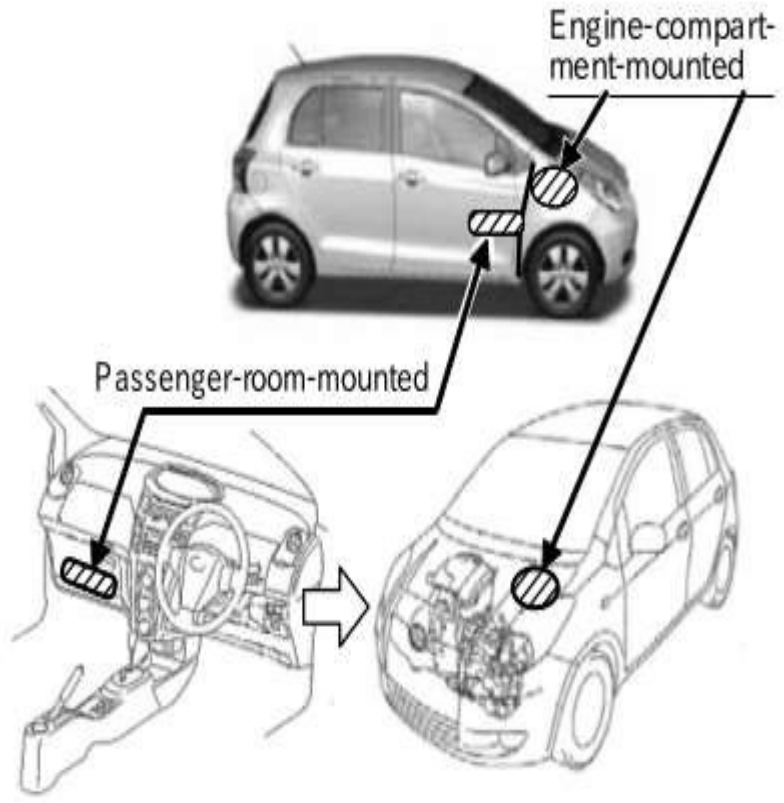
•Automotive electronics originated from the need to control Engines.

•The first electronic pieces were used to control engine functions and were referred to as engine control units (ECU).

•A modern car may have up to 100 ECU's and a commercial vehicle up to 40.

What is an ECU

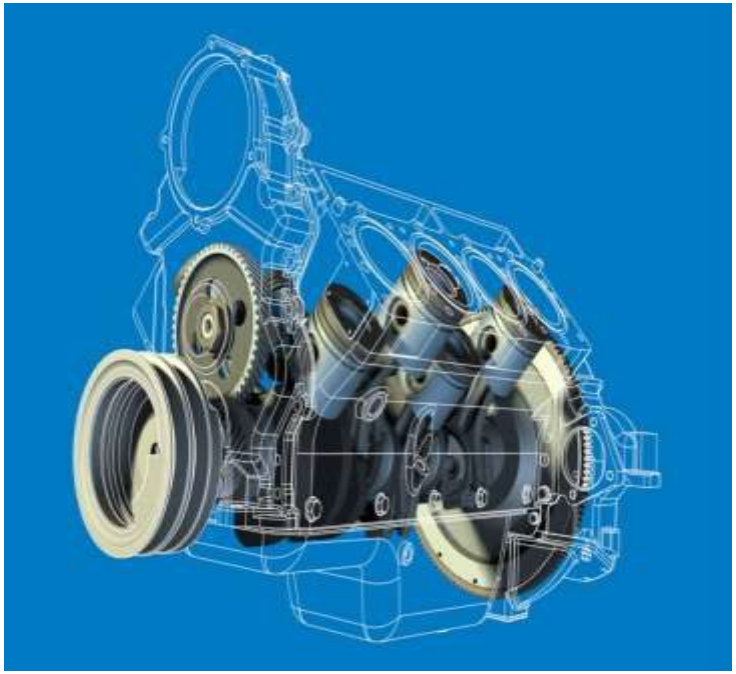
In the Automobile industry an electronic control unit (ECU) is an embedded electronic device, basically a digital computer, that reads signals coming from sensors placed at various parts and in different components of the car and depending on this information controls various important units e.g. engine and other automated operations within the car among many.



ECU(Electronic Control Unit) and its mount location

Types of ECU

ECM - Engine Control Module
EBCM - Electronic Brake Control Module
PCM – Power train Control Module
VCM - Vehicle Control Module
BCM - Body Control Module



What an ECU does

The ECU uses **closed-loop control**, a control scheme that monitors outputs of a system to control the inputs to a system, managing the emissions and fuel economy of the engine (as well as a host of other parameters).

Gathering data from dozens of different sensors, the ECU performs millions of calculations each second, including looking up values in tables, calculating the results of long equations to decide on the best spark timing or determining how long the fuel injector is open.

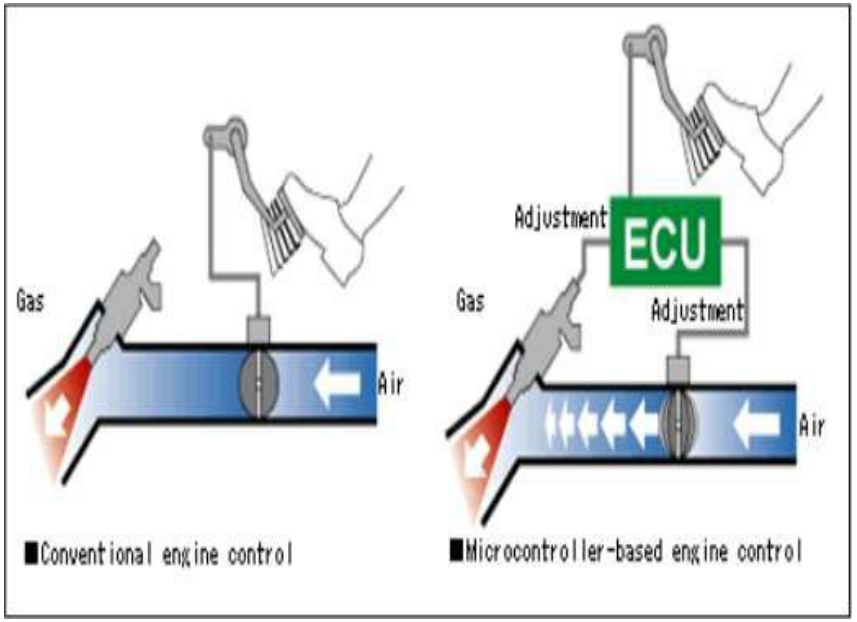
Number Crunching

A modern ECU might contain a 32-bit, 40-MHz processor, which may not sound fast compared to the processors we probably have in our PCs, but the processor in our car runs a much more efficient code. The code in an average ECU takes up less than 1 megabyte(MB) of memory. By comparison, we probably have at least 2 gigabytes (GB) of programs on our computers -- 2,000 times the amount in an ECU.

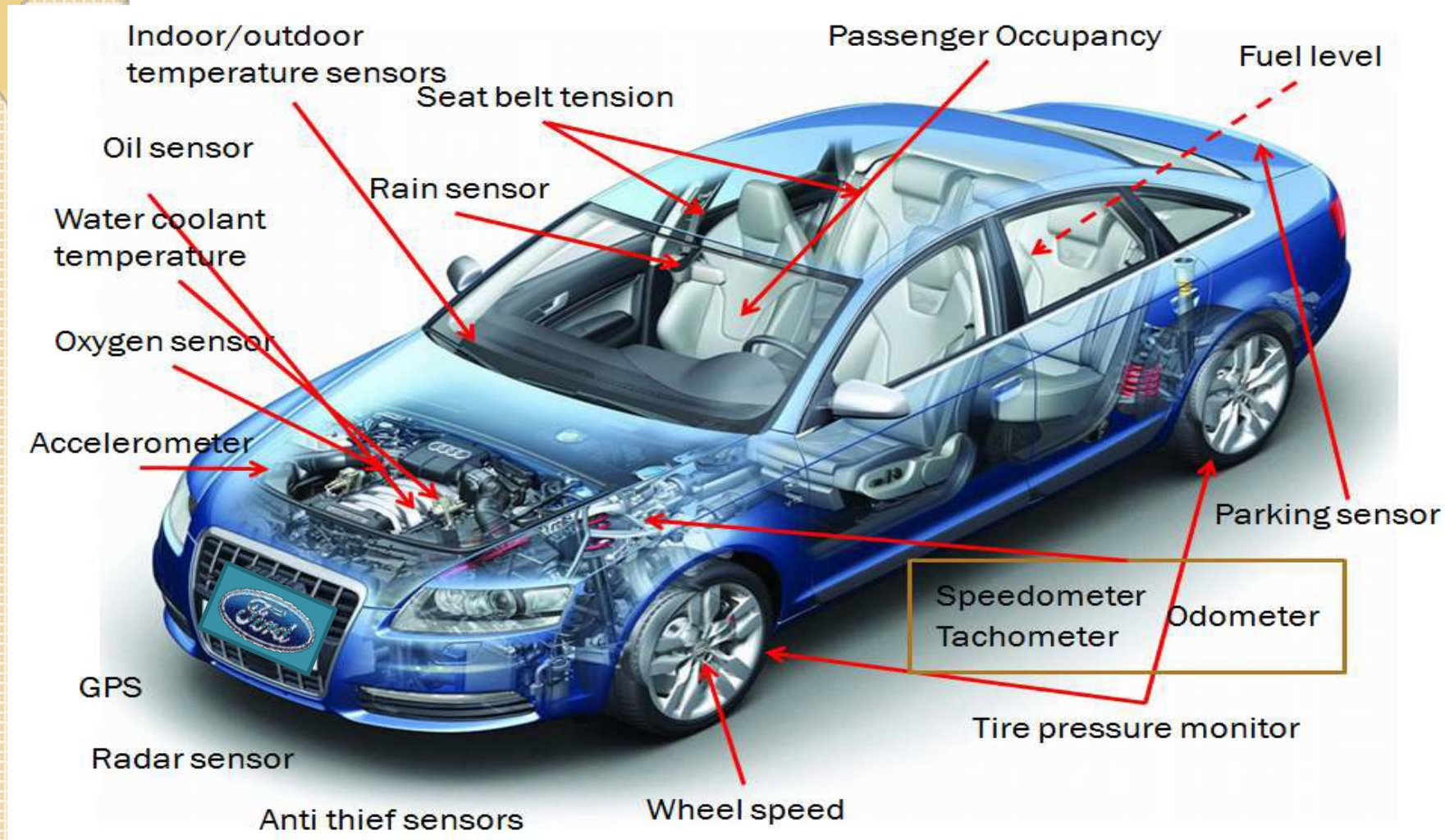
Applications

Depending upon the nature of the circuit the Engine mappings can change completely. On slower and twister tracks, the engine control system will help the driver have more control on the throttle input by making the first half of the pedal movement very sensitive.

At high speed circuits, the driver has to jump on the throttle more, rather than gradually applying full throttle. The accelerator will be set so that only a small movement will result in full engine acceleration.



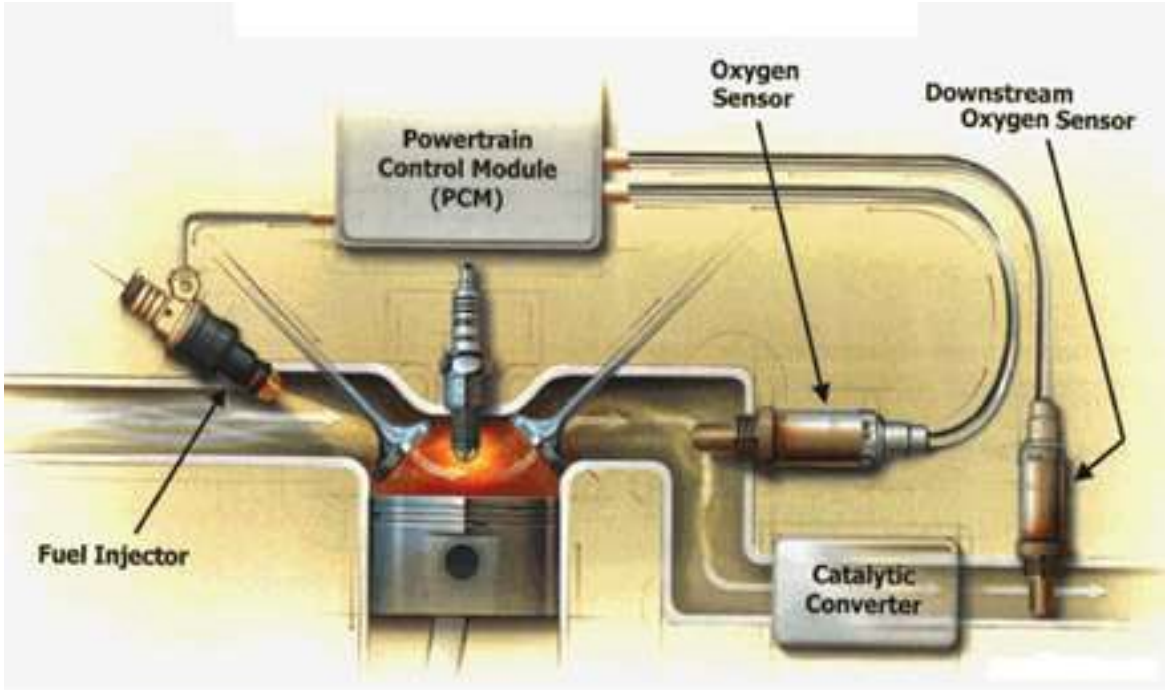
Types Of Automotive Sensors



TYPES OF SENSORS

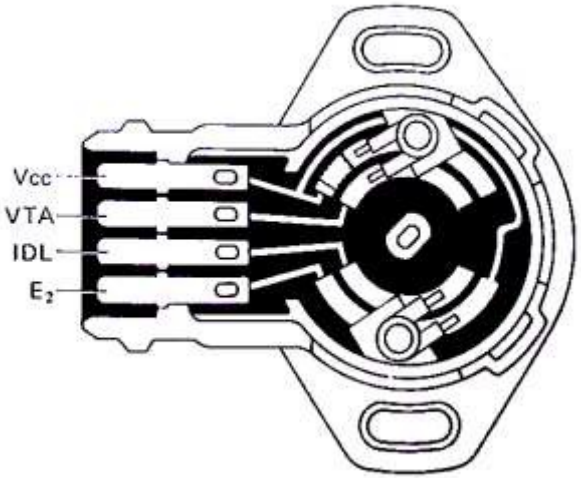
- **ENGINE SENSORS**
  - Oxygen Sensor
  - Throttle Position Sensor
  - Crankshaft Position Sensor
  - MAP Sensor
  - Engine Coolant Temperature Sensor
  - Mass Air Flow Sensor

OXYGEN SENSOR



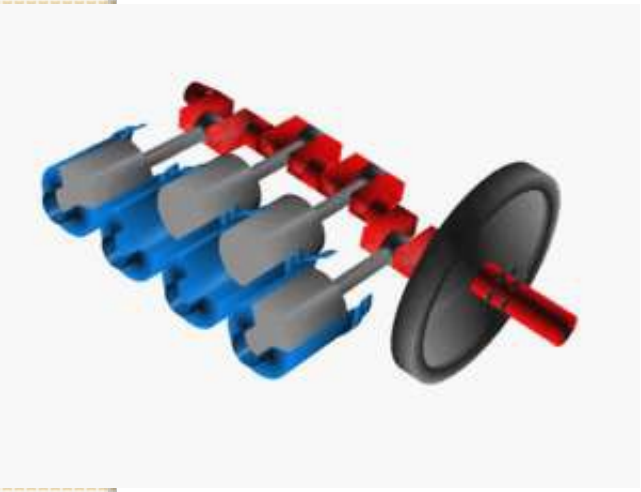
This sensor is used in the mechanism serving for air fuel ratio measurement, it is installed in the exhaust system of the vehicle, attached to the engine's exhaust manifold, the sensor measures the ratio of the air-fuel mixture.

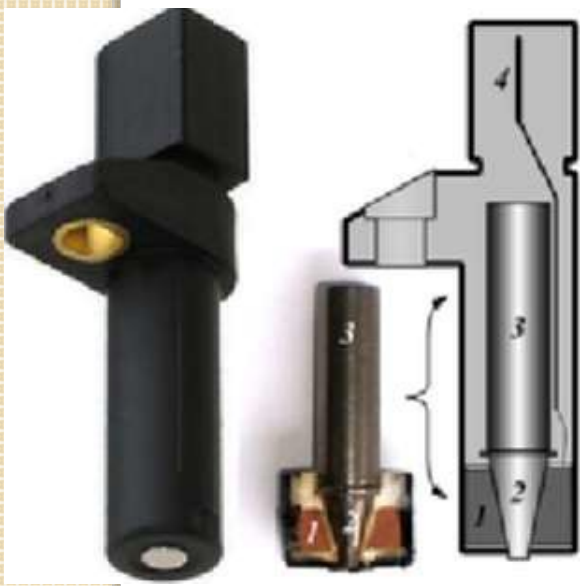
THROTTLE POSITION SENSOR



A **throttle position sensor** is a sensor used to monitor the position of the throttle in an internal combustion engine. The sensor is usually located on the butterfly spindle so that it can directly monitor the position of the throttle valve butterfly.

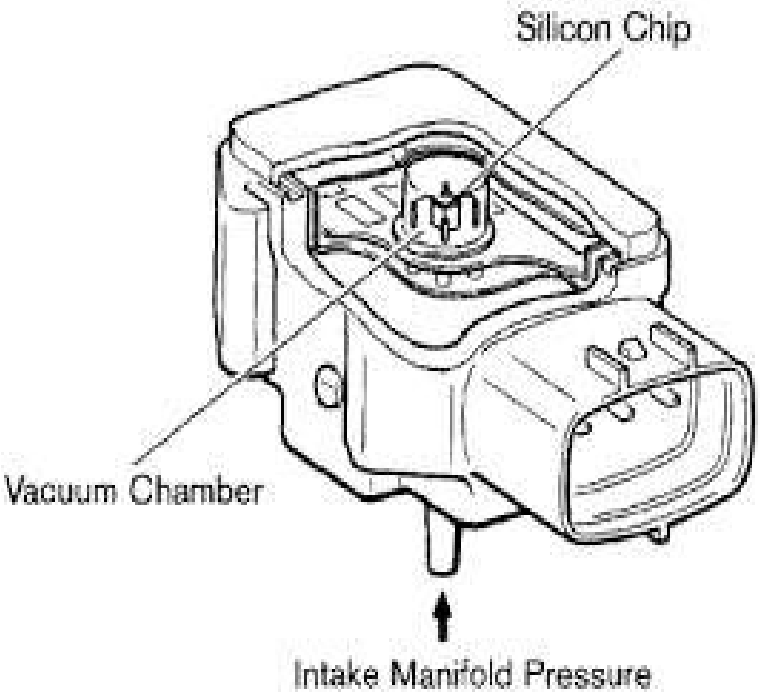
CRANK POSITION SENSOR

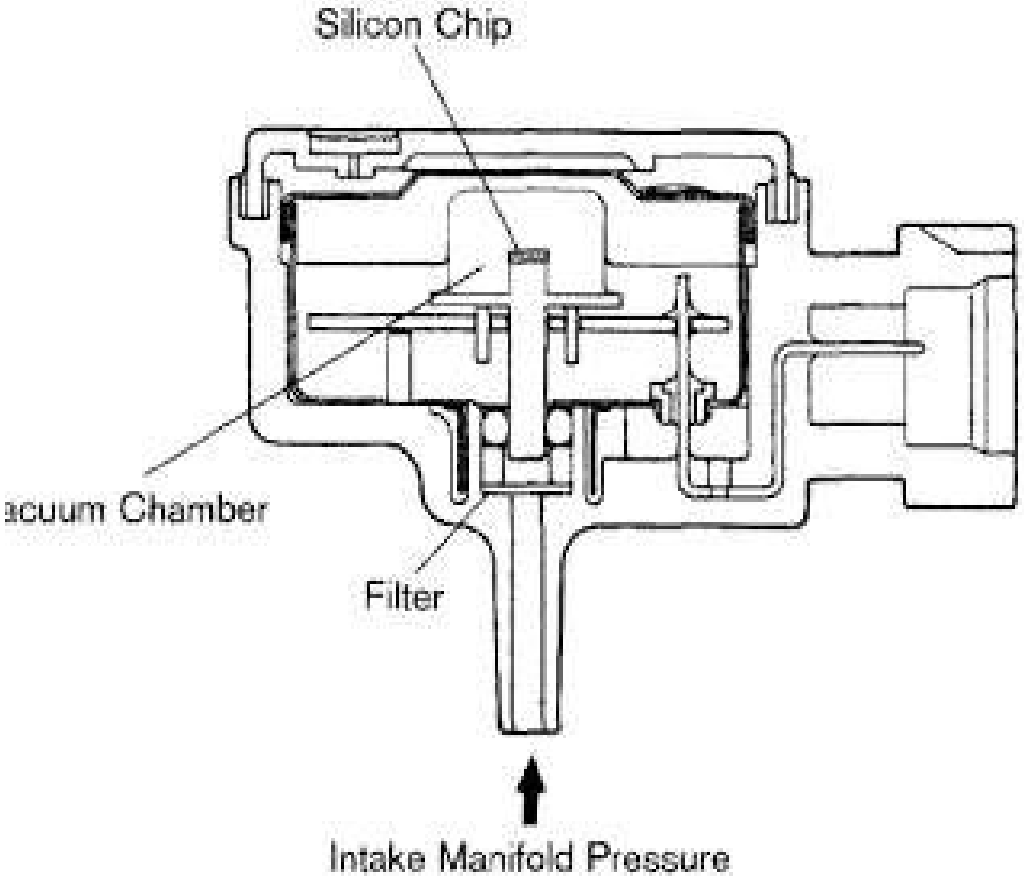




A **crank position sensor** is a component used in an internal combustion engine to monitor the position or rotational speed of the crankshaft. This information is used by engine management systems to control ignition system timing and other engine parameters.

MAP SENSOR


Silicon Chip
Vacuum Chamber
Intake Manifold Pressure


Silicon Chip
acuum Chamber
Filter
Intake Manifold Pressure

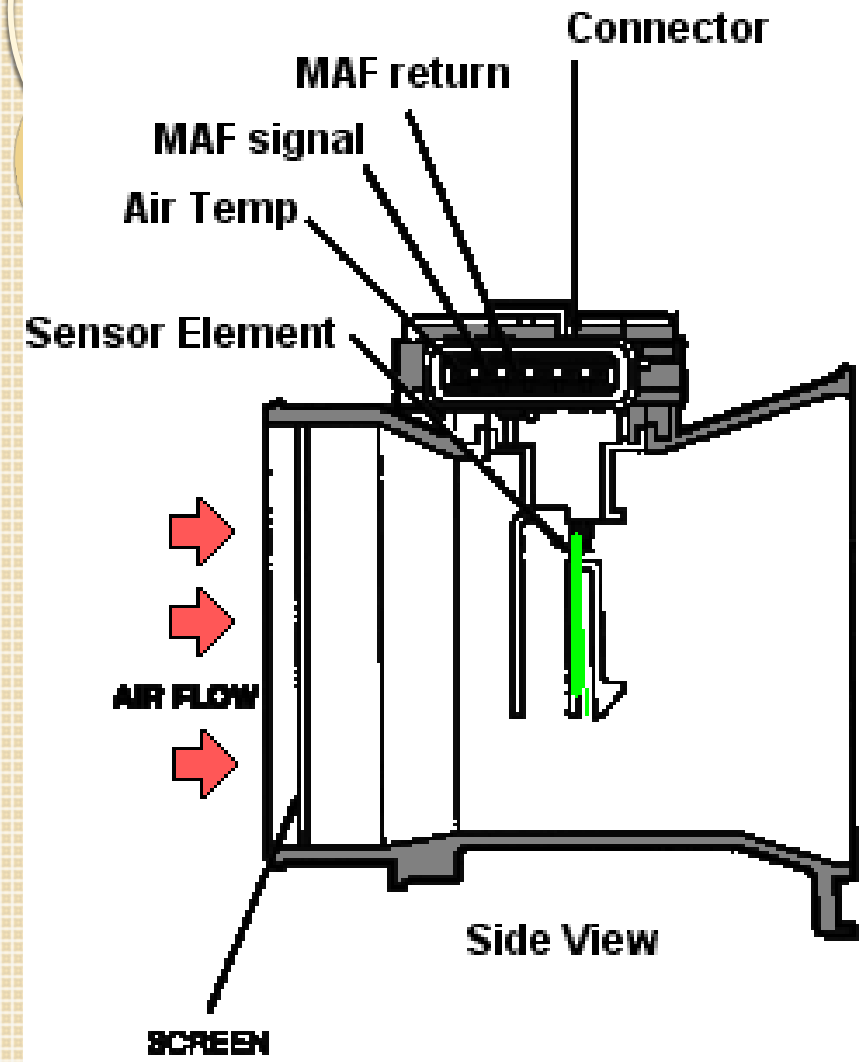
MAP SENSOR

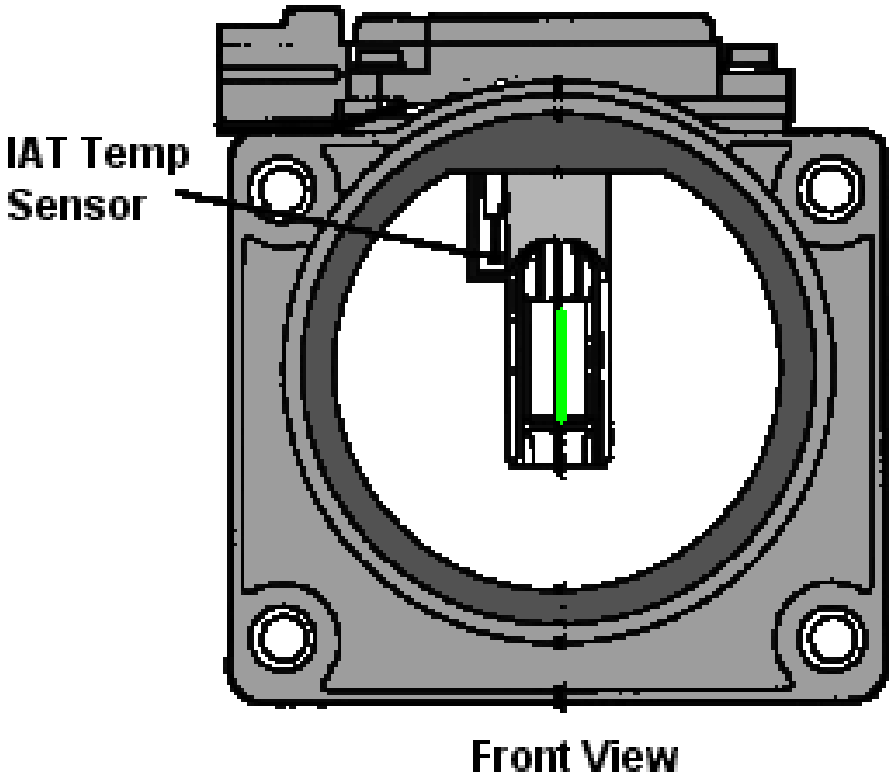
- A **manifold absolute pressure sensor** (MAP) is one of the sensors used in an internal combustion engine's electronic control system.
- The manifold absolute pressure sensor provides instantaneous manifold pressure information to the engine's electronic control unit (ECU).
- The data is used to calculate air density and determine the engine's air mass flow rate, which in turn determines the required fuel metering for optimum combustion.
- A fuel-injected engine may alternately use a MAF (mass air flow) sensor to detect the intake airflow. A typical configuration employs one or the other, but seldom both

Coolant Temperature Sensor

- The coolant temperature sensor is used to measure the temperature of the engine coolant of an internal combustion engine.
- The readings from this sensor are then fed back to the Engine control unit (ECU). This data from the sensor is then used to adjust the fuel injection and ignition timing.
- On some vehicles the sensor may be used to switch on the electronic cooling fan. The data may also be used to provide readings for a coolant temperature gauge on the dash.
- The coolant temperature sensor works using resistance. As temperature subjected to the sensor increases the internal resistance changes.
- Depending on the type of sensor the resistance will either increase or decrease.

Mass Air Flow Sensor





Mass Air Flow Sensor

A mass air flow sensor (MAF) is used to find out the mass flow rate of air entering a fuel-injected internal combustion engine.

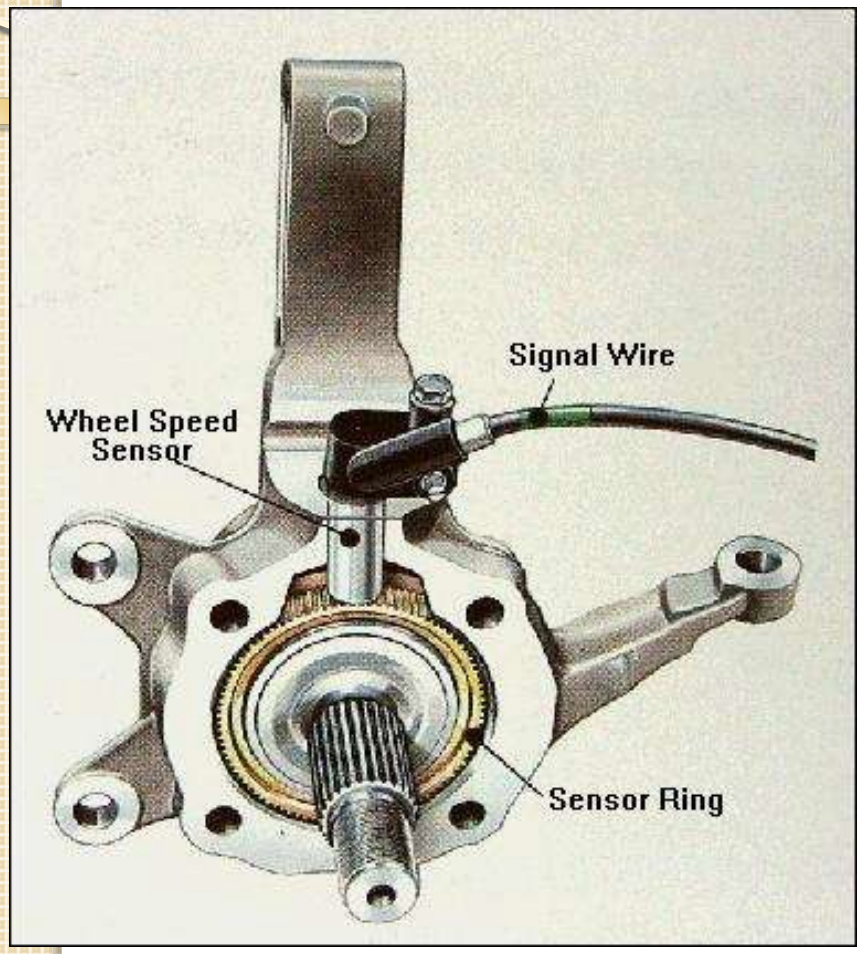
The air mass information is necessary for the engine control unit (ECU) to balance and deliver the correct fuel mass to the engine. Air changes its density as it expands and contracts with temperature and pressure. In automotive applications, air density varies with the ambient temperature, altitude and the use of forced induction, which means that mass flow sensors are more appropriate than volumetric flow sensors for determining the quantity of intake air in each piston stroke

SPEED SENSORS

Speed sensors are machines used to detect the speed of an object, usually a transport vehicle. They include:

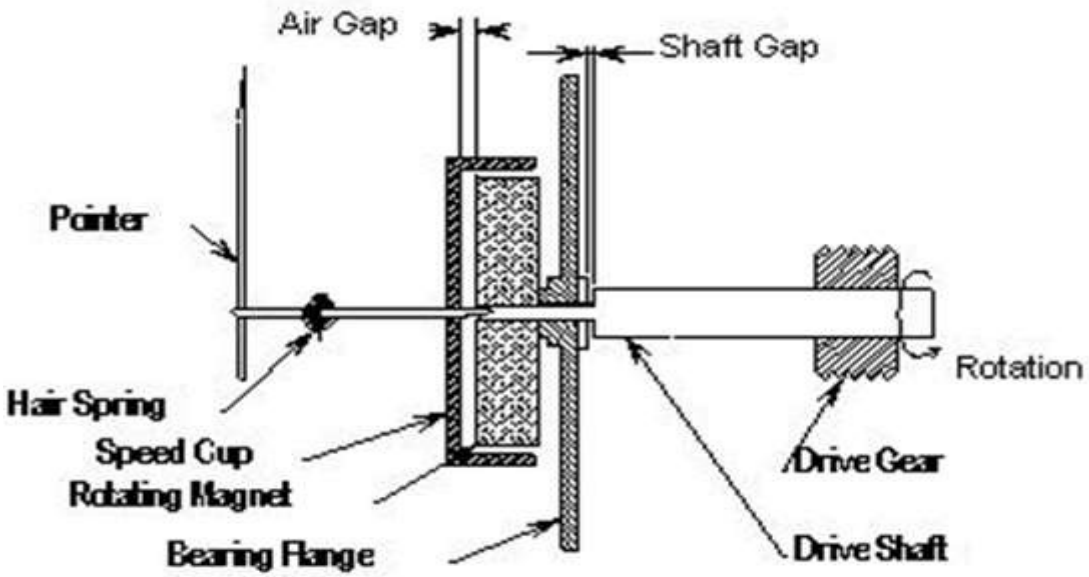
- Wheel speed sensors
- Speedometers
- Pitometer logs
- Pitot tubes
- Airspeed indicators
- Piezo sensors (e.g. in a road surface)
- LIDAR
- ANPR (where vehicles are timed over a fixed distance)

WHEEL SPEED SENSOR



A **wheel speed sensor** or vehicle speed sensor (VSS) is a type of tachometer. It is a sender device used for reading the speed of a vehicle's wheel rotation. It usually consists of a toothed ring and pickup.

SPEEDOMETER

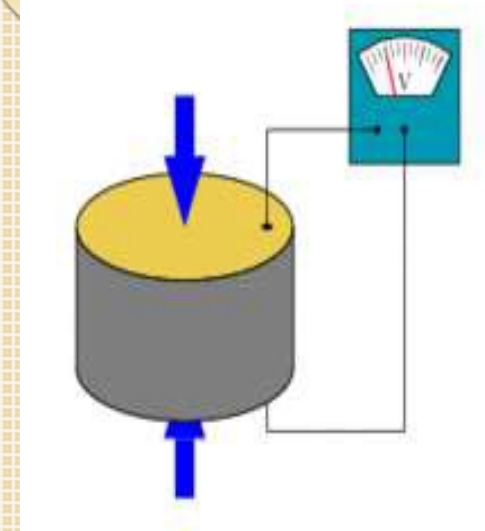


A **speedometer** is a device that measures the instantaneous speed of a land vehicle.

The various types of speedometers include:

- Eddy current speedometer
- Electronic speedometer
- Bicycle speedometer

PIEZOELECTRIC SENSORS



A piezoelectric disk generates a voltage when deformed (change in shape is greatly exaggerated)

A **piezoelectric sensor** is a device that uses the piezoelectric effect to measure pressure, acceleration, strain or force by converting them to an electrical signal.

In the automotive industry, piezoelectric elements are used to monitor combustion when developing internal combustion engines.

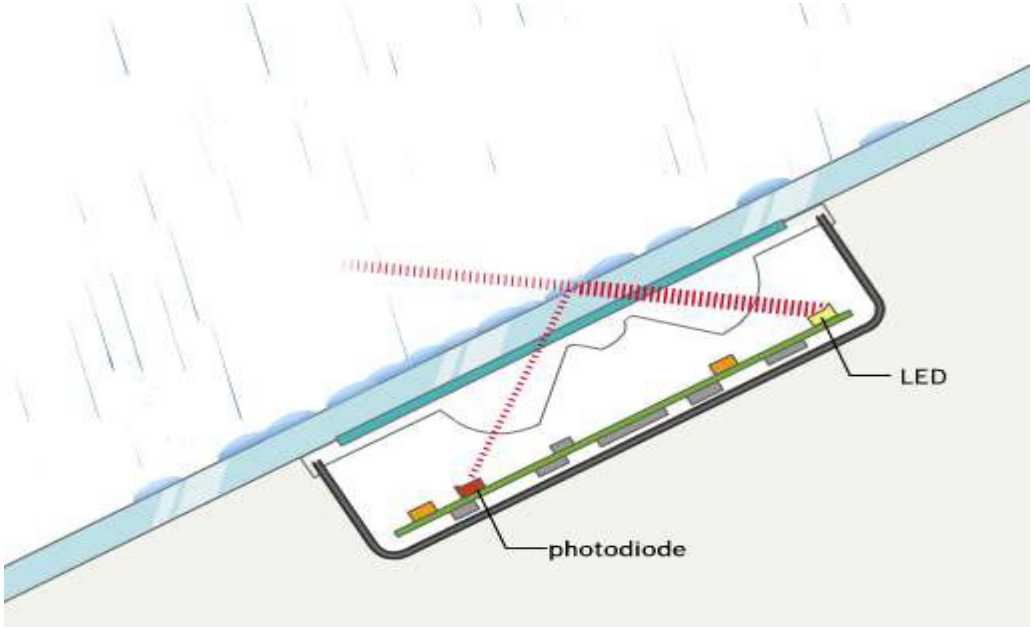
LIDAR

- **LIDAR** (**Li**ght **D**etection **A**nd **R**anging) is an optical remote sensing technology that measures properties of scattered light to find range and/or other information of a distant target.
- The prevalent method to determine distance to an object or surface is to use laser pulses.
- Like the similar radar technology, which uses radio waves, the range to an object is determined by measuring the time delay between transmission of a pulse and detection of the reflected signal.

TYPES OF VEHICLE SENSORS

- Rain Sensor
- Parking sensor
- Air Conditioning Sensor
- Oil sensor
- Fuel gauge
- Radar gun
- Water Sensor

RAIN SENSORS



Automotive rain sensors detect rain falling on the windshield of a vehicle. One of the more common rain sensor implementations employs an infrared light that is beamed at a 45-degree angle onto the windshield from inside the car. If the glass is wet, less light makes it back to the sensor, and the wipers turn on.

PARKING SENSORS

Parking sensors are proximity sensors for road vehicles which can alert the driver to unseen obstacles during parking manoeuvres.

The ultrasonic sensors are currently available in several brands of cars. Some systems are also available as additional upgrade kits for later installation.

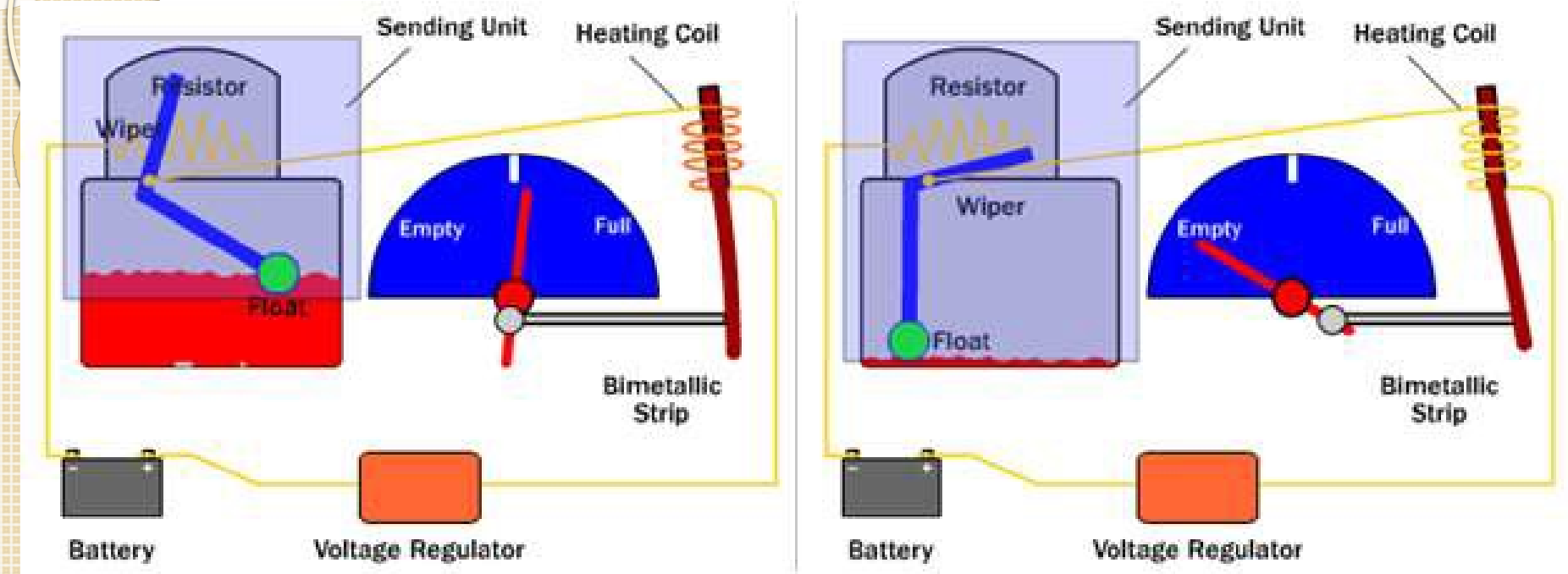
OIL SENSORS

Oil sensors and oil analyzers are used in automotive or industrial machinery applications to sense oil levels, and check for:

- Contamination
- Particulates
- Viscosity
- Temperature

Oil sensors and oil analyzers are also known as ferrography instruments.

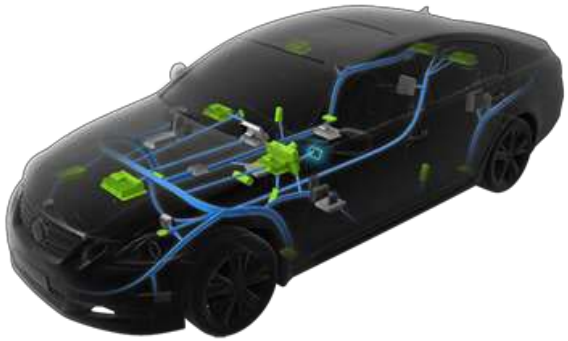
FUEL GAUGE



A **fuel gauge** is an instrument used to indicate the level of fuel contained in a tank. As used in cars, the gauge consists of two parts:

- The sensing unit
- The indicator

Types Of Sensors used in ECU



Working of different sensors.

Actuators

What is an actuator?

- Actuators are devices used to produce action or motion.
- Input(mainly electrical signal , air, fluids)
- Electrical signal can be low power or high power.
- Actuators output can be position or rate i. e. linear displacement or velocity

Classification of Actuators

- *Pneumatic*
- *Hydraulic*
- *Electrical/Electronic*

Pneumatic Actuators

Pneumatic Actuators

- *A set of devices into with one or more pneumoengines, which are determined to start mechanisms or some other objects by means of pressed working gas is called pneumatic actuator, or pneumoactuator.*
- *The devices intended for transformation of potential and kinetic energy of the stream of compressed gas in mechanical energy of the output link that can be, for example, a rod of the piston, a shaft of the turbine or the case of the jet device is called pneumatic engines of the automated actuator.*
- *They are devices providing power and motion to automated systems, machines and processes.*
- *A pneumatic cylinder is a simple, low cost, easy to install device that is ideal for producing powerful linear movement.*

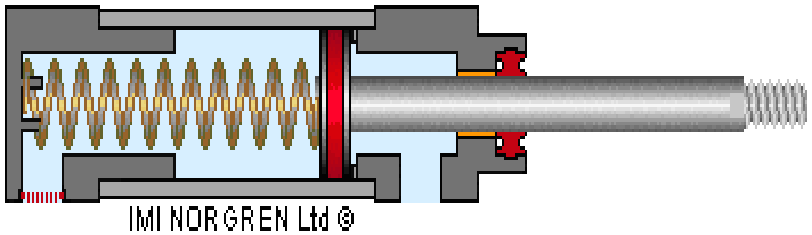
Types of Pneumatic Actuator

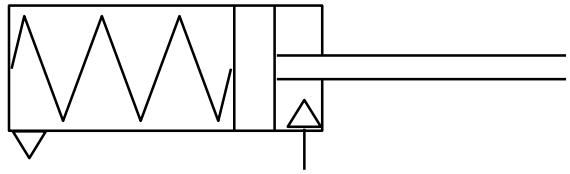
- *Pneumatic actuators are made in a wide variety of sizes, styles and types including the following :*

1. *Single acting with and without spring return*
2. *Double acting*

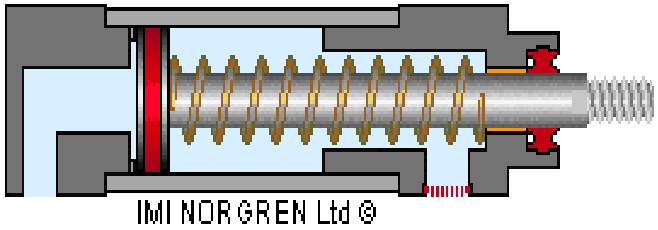
Single acting spring return

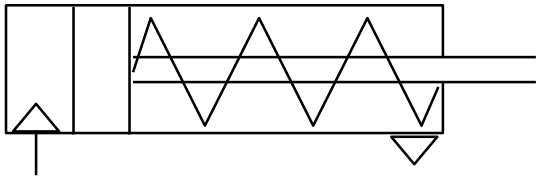
- *Single acting cylinders have a power stroke in one direction only*
- *Normally in*





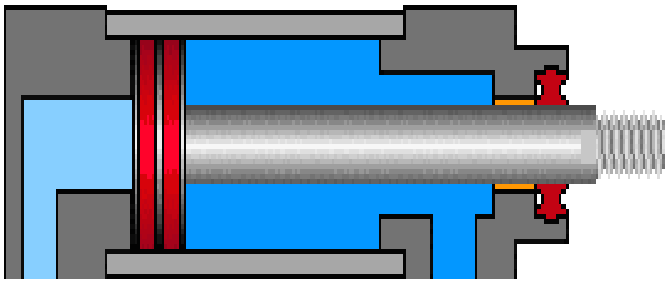
- *Normally out*

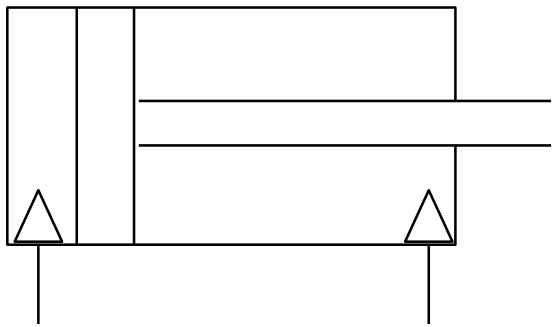




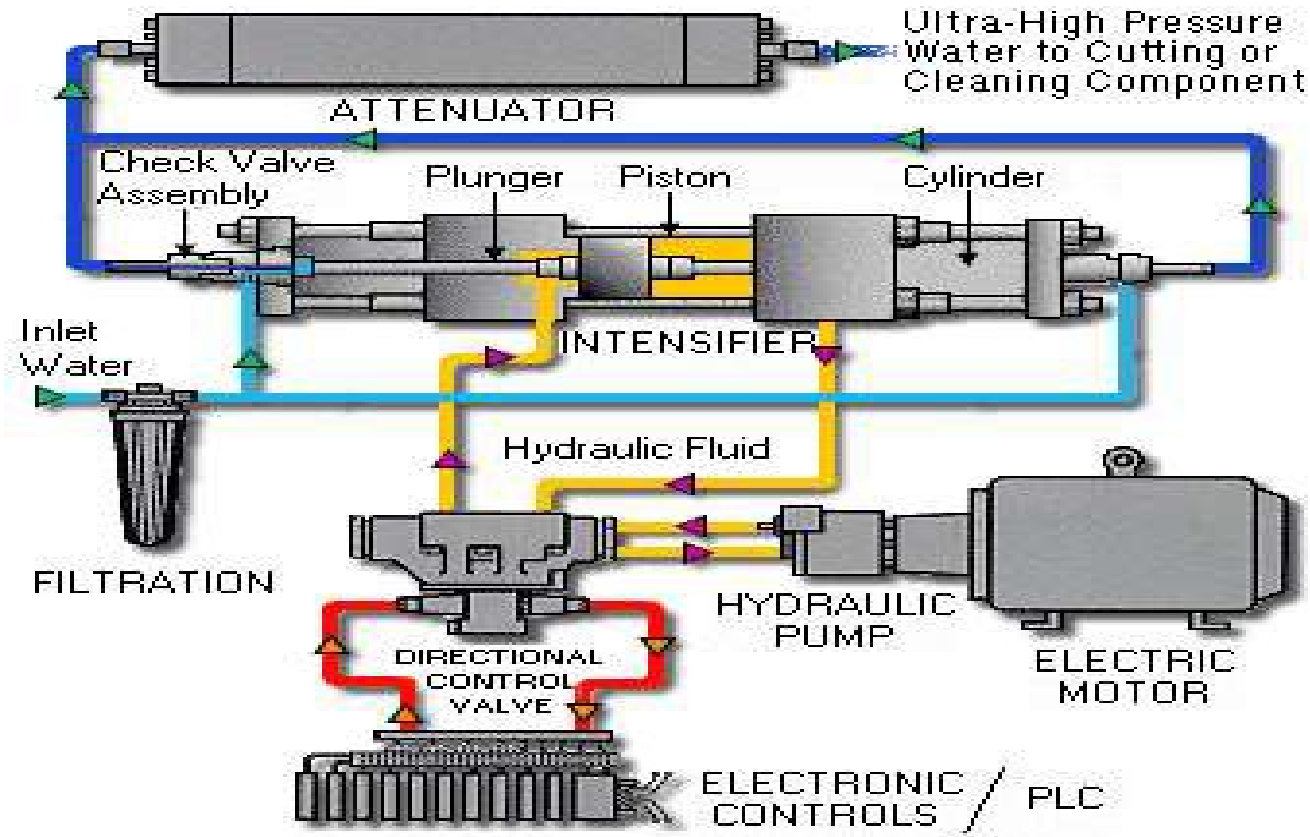
Double acting

- *Double acting cylinders use compressed air to power both the outstroke and instroke.*
- *Superior speed control is possible*
- *Non cushioned cylinders are suitable for full stroke working at slow speed.*
- *Higher speeds with external cushions.*





Hydraulic Actuator



Introduction

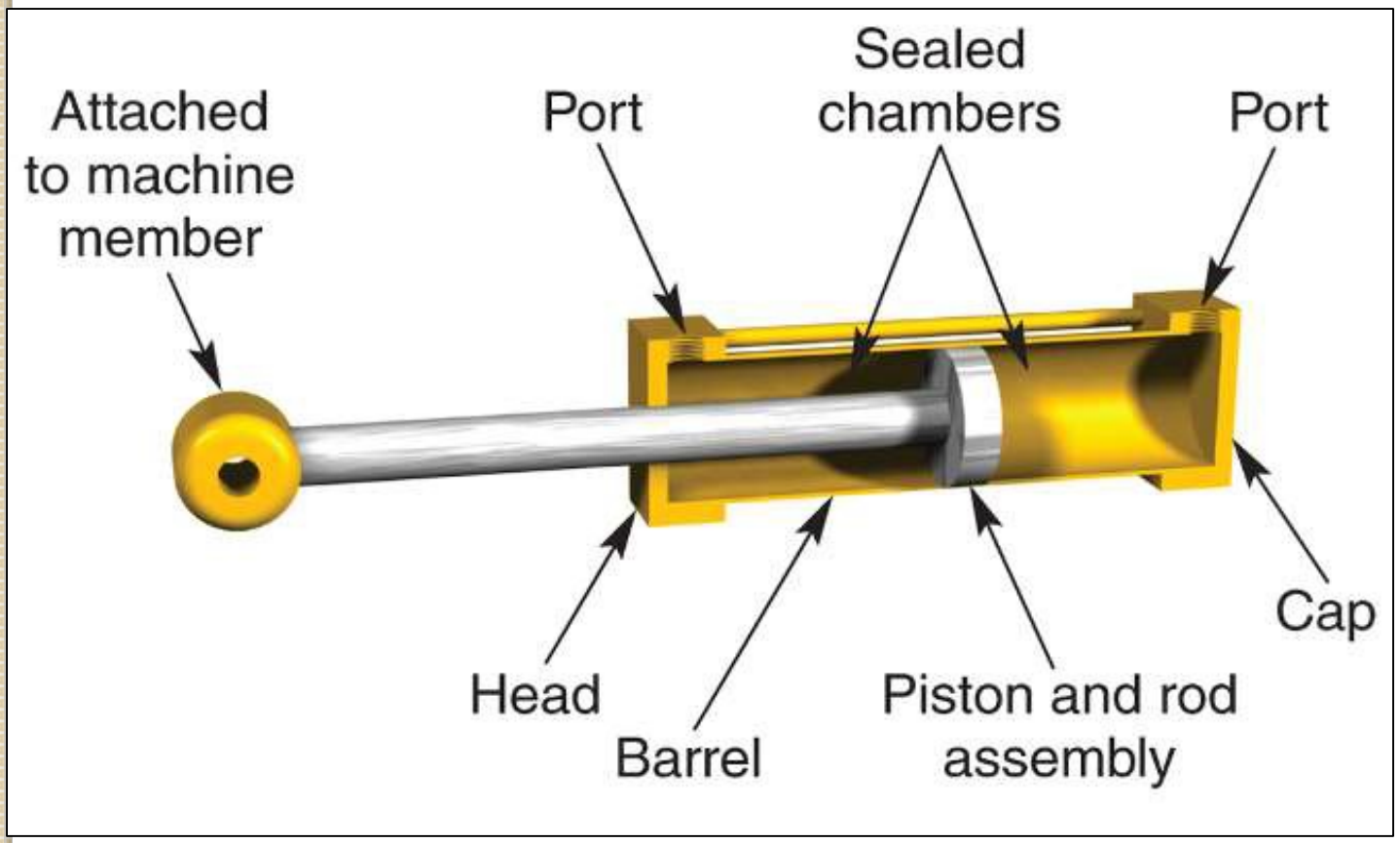
- *A **hydraulic drive system** is a drive or transmission system that uses pressurized hydraulic fluid to drive hydraulic machinery.*

- *The term "hydraulic actuator" refers to a device controlled by a hydraulic pump.*

- *A familiar example of a manually operated hydraulic actuator is a hydraulic car jack. Typically though, Principle Used in Hydraulic Actuator System*

Hydraulic Actuator

- Parts of a typical cylinder



Working of Hydraulic Actuators

- *Hydraulic actuators or hydraulic cylinders typically involve a hollow cylinder having a piston inserted in it. An unbalanced pressure applied to the piston provides force that can move an external object. Since liquids are nearly incompressible, a hydraulic cylinder can provide controlled precise linear displacement of the piston. The displacement is only along the axis of the piston.*
- *The piston forms sealed, variable-volume chambers in the cylinder*
- *System fluid forced into the chambers drives the piston and rod assembly*
- *Linear movement is produced*

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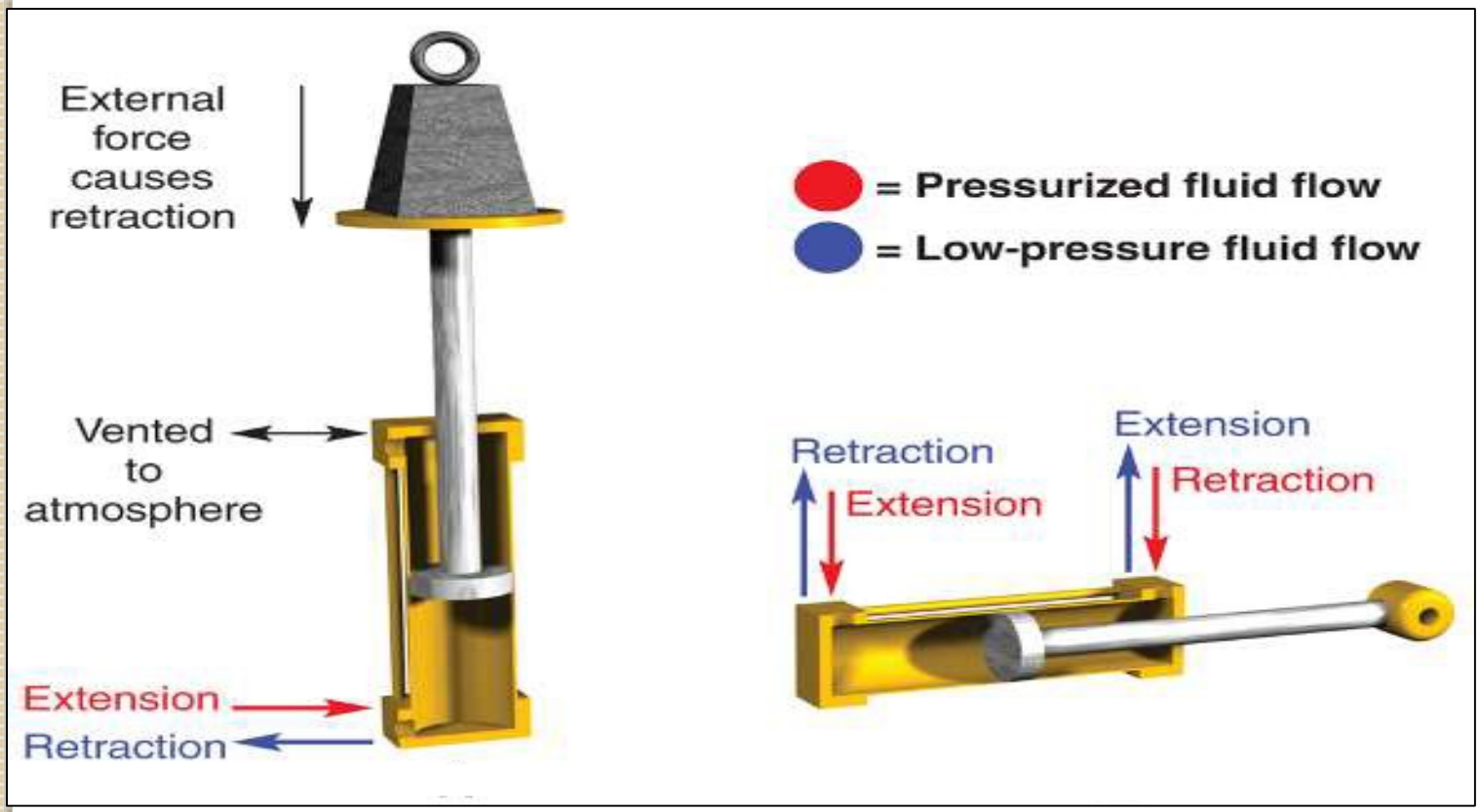
Classifications of Hydraulic Actuator

- *Cylinders are typically classified by operating principle or by construction type*
  - *Single-acting or double-acting*
  - *Tie rod, mill, threaded end, or one piece*
- ***Single-acting cylinders** exert force either on extension or retraction.*
- *They require an outside force to complete the second motion*
- ***Double-acting cylinders** generate force during both extension and retraction*
  - *Directional control valve alternately directs fluid to opposite sides of the piston*
  - *Force output varies between extension and retraction*

Hydraulic Actuator

- Single- and Double-Acting Cylinders



Single-acting

Double-acting

Electrical

Introduction

- *An electrical motor is an Transducer & an Actuator because it converts electrical current into a large magnetic field which then turns a shaft. (Mechanical energy)*
- *All electric motors use electromagnetic induction to generate a force on a rotational element called the rotor.*
- *The torque required to rotate the rotor is created due to the interaction of magnetic fields generated by the rotor, and the part surrounding it, which is fixed, and called the stator.*

Classification of Electrical Actuators

- Solenoid
- Electrical Motors
- Stepping Motors

Electrical actuator

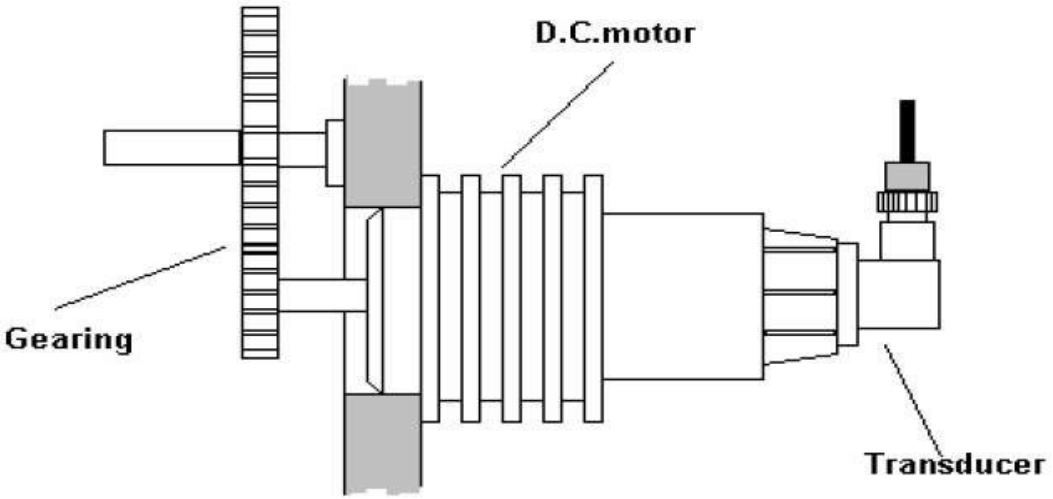
- Electrically actuated system are very widely used in control system

Working Principle of motor

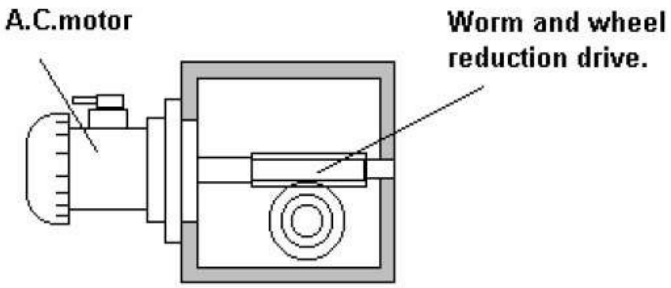
Every motor works on the principle that when a current-carrying conductor is placed in a magnetic field, it experiences a mechanical force.

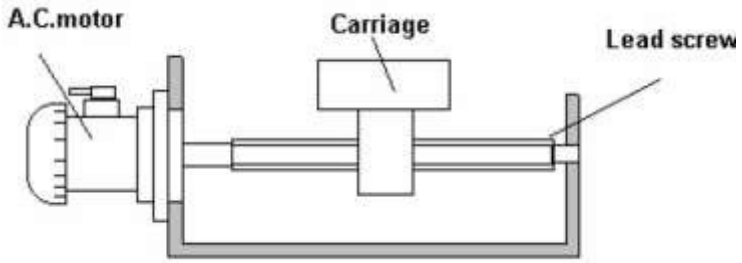
- There are three types of motor used in control system

- D.C. motor
- A.C. motor
- Stepper motor



➢A.C. motor





➢Stepper motor

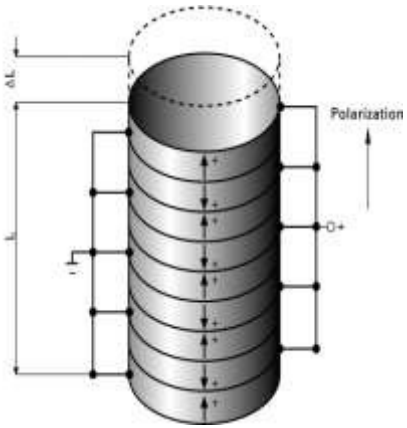
A stepper motor is an electromechanical device which converts electrical pulses into discrete mechanical movements.

- ➢Permanent magnet type
- ➢Variable reluctance type
- ➢Hybrid type

Piezoelectric actuators

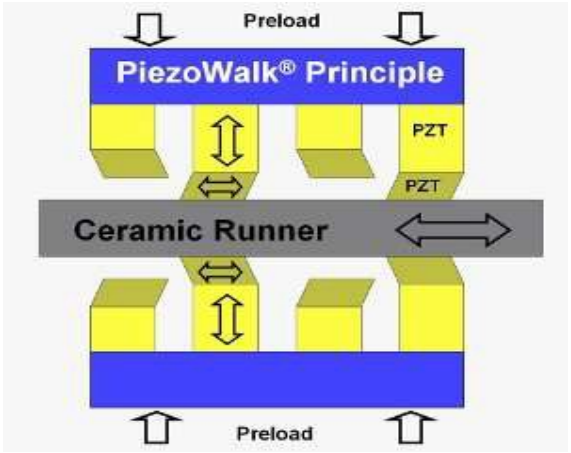
- **Pierre** and **Jacques Curie** discovered the piezoelectric effect in 1880.
- The application of an electric field to a piezoelectric crystal leads to a physical deformation of the crystal.
- Piezoelectric materials are: **Quartz, Ceramics, PZT(lead zirconate titanade).**
- **Advantages**
  - short response time.
  - An ability to create high forces.
  - A high efficiency and a high mechanical durability.
- **Disadvantage**
  - Have small strains. (0.1-.2%)
  - High supply voltage needed.(60-1000V)
  - Large hysteresis.(actuator doesn't go back to exactly where it started).

Types of piezoelectric actuators

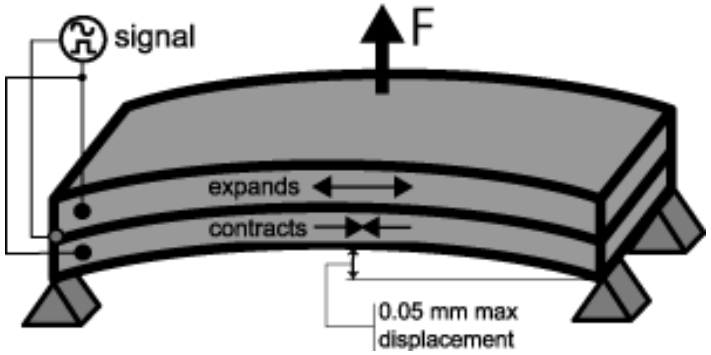


- Piezoelectric Stack Actuators
  - Produce linear motion.

- Linear motor



- Piezoelectric bender actuator



Other type of actuator

Heaters - used with temperature sensors And temperature controller to control the temperature in automated moulding Equipment and in soldering operation.

Lights - Lights are used on almost all machines to indicate the machine state and provide feedback to the operator.

- LED
- LCD's
- Gas plasma display
- CRT

Sirens / Horns - Sirens or horns can be useful for unattended or dangerous machines to make conditions well known.

Environmental Pollution Control Techniques

Introduction

- **Pollution** is the introduction of contaminants into the natural environment that cause adverse change.
- Pollution can take the form of chemical substances or energy, such as noise, heat or light.
- Components of pollution, can be either foreign substances/energies or naturally occurring contaminants.
- Pollution is often classed as Point source or Nonpoint source pollution

Types of pollution

The major forms of pollution are listed:

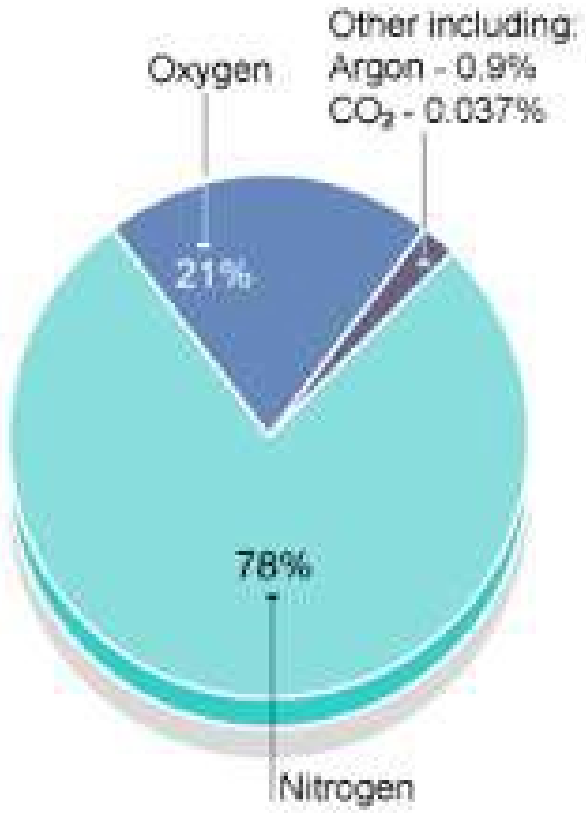
- Air pollution
- Light pollution
- Littering
- Noise pollution
- Soil contamination
- Radioactive contamination
- Thermal pollution
- Visual pollution
- Water pollution
- Plastic pollution

AIR POLLUTION

AIR POLLUTION

- Atmospheric condition in which presence of certain substances in such concentrations produce undesirable effects on man and environment
- They may be gases or particulate matter
- SO_Xs, NO_Xs,CO, hydrocarbons etc are some of the gases
- Smoke, dust, fumes and aerosols are some of the particulate matter
- Their presence in an amount greater than their natural percentage is considered to be causing air pollution

Composition of clean, dry air



Sources of air pollution

Stationary and Area Sources

- A **stationary source** of air pollution refers to an emission source that does not move, also known as a point source.
- Stationary sources include factories, power plants, dry cleaners and degreasing operations.
- The term **area source** is used to describe many small sources of air pollution located together whose individual emissions may be below thresholds of concern, but whose collective emissions can be significant.
- Residential wood burners are a good example of a small source, but when combined with many other small sources, they can contribute to local and regional air pollution levels.
- Area sources can also be thought of as non-point sources,

Sources of air pollution

Mobile Sources

- A **mobile source** of air pollution refers to a source that is capable of moving under its own power.
- In general, mobile sources imply "on-road" transportation, which includes vehicles such as cars, sport utility vehicles, and buses.
- In addition, there is also a "non-road" or "off-road" category that includes gas-powered lawn tools and mowers, farm and construction equipment, recreational vehicles, boats, planes, and trains.

Sources of air pollution

Agricultural Sources

- **Agricultural operations**, those that raise animals and grow crops, can generate emissions of gases and particulate matter.
- For example, animals confined to a barn or restricted area (rather than field grazing), produce large amounts of manure
- Manure emits various gases, particularly ammonia into the air.
- This ammonia can be emitted from the animal houses, manure storage areas, or from the land after the manure is applied.
- In crop production, the misapplication of fertilizers

Sources of air pollution

Natural Sources

- It include wild land fires, dust storms, and volcanic activity also contribute gases and particulates to our atmosphere.
- Unlike the above mentioned sources of air pollution, natural "air pollution" is not caused by people or their activities.
- An erupting volcano emits particulate matter and gases; forest and prairie fires can emit large quantities of "pollutants”
- Plants and trees naturally emit VOCs which are oxidized and form aerosols that can cause a natural blue haze
- Dust storms can create large amounts of particulate

Criteria Pollutants

- We have identified six common air pollutants of concern and are called *criteria pollutants*.
- The criteria pollutants are carbon monoxide, lead, nitrogen dioxide, ozone, particulate matter, and sulphur dioxide.
- Criteria pollutants are the only air pollutants with national air quality standards that define allowable concentrations of these substances in ambient air.
- Exposure to these substances can cause health effects, environmental effects, and property damage.
- Health effects include heart or lung disease, respiratory damage, or premature death. Environmental effects include smog, acid rain, radiation, and ozone depletion.

Carbon Monoxide (CO)

- Carbon monoxide (CO) is a colourless, odourless, and poisonous gas and one of six criteria pollutants for which EPA has established protective standards.
- CO forms when the carbon in fuels does not completely burn. Vehicle exhaust contributes roughly 60% of all CO emissions nationwide and up to 95% in cities.
- Other sources include fuel combustion in industrial processes and natural sources such as wildfires.
- CO concentrations typically are highest during cold weather because cold temperatures make combustion less complete and cause inversions that trap pollutants low to the ground.

CARBON MONOXIDE (CO) POISONING

CAN'T BE SEEN

CAN'T BE SMELLED

CAN'T BE HEARD

CAN BE STOPPED

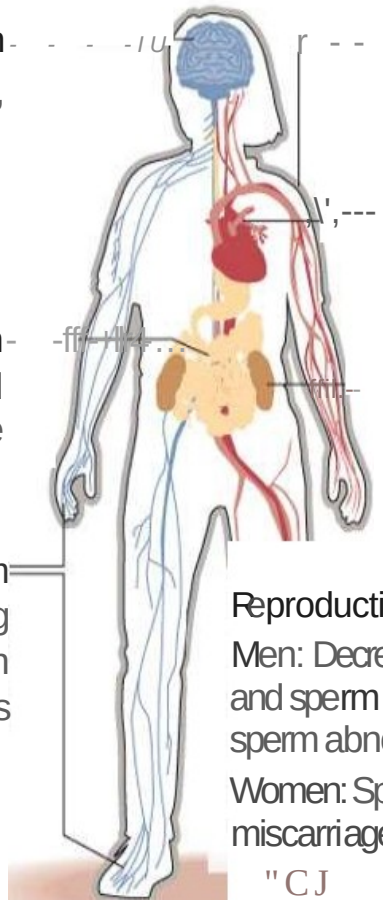
Health Impacts of Exposure

- CO enters the bloodstream through the lungs and binds chemically to haemoglobin, the substance in blood that carries oxygen to cells.
- In this way, CO interferes with the ability of the blood to transport oxygen to organs and tissue throughout the body.
- This can cause slower reflexes, confusion, and drowsiness.
- It can also re[d] and decrease

Lead

- Lead is a metal found naturally in the environment as well as in manufactured products.
- It is one of six criteria pollutants for which EPA has established protective standards.
- Exposure to lead can occur through multiple pathways, including inhalation of air and ingestion of lead in food, water, soil, or dust.
- Historically, the major sources of lead emissions were motor vehicles (such as cars and trucks) and industrial sources.
- Due to the phase-out of leaded gasoline, however, airborne lead is no longer a problem in most of the developed and developing world.
- The major source of lead emissions today is metals processing and the highest levels of lead in air are

ADULTS



Brain

Memory loss, lack of concentration, headaches, irritability, depression

Body

Fatigue, joint and muscle pain

Cardiovascular

High blood pressure

Digestive system

Constipation, nausea and poor appetite

Kidneys

Abnormal function and damage

Nervous system

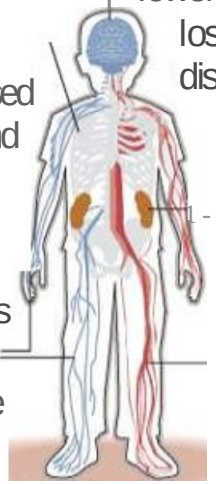
Damage including numbness and pain in the extremities

Reproductive system

Men: Decreased sex drive and sperm count, and sperm abnormalities.

Women: Spontaneous miscarriage

CHILDREN



Brain

Behavior problems, lower IQ, hearing loss, learning disabilities

Body

Decreased bone and muscle growth

Kidneys

Damage

Nervous system

Damage

Blood

Anemia

Health Impacts of Exposure

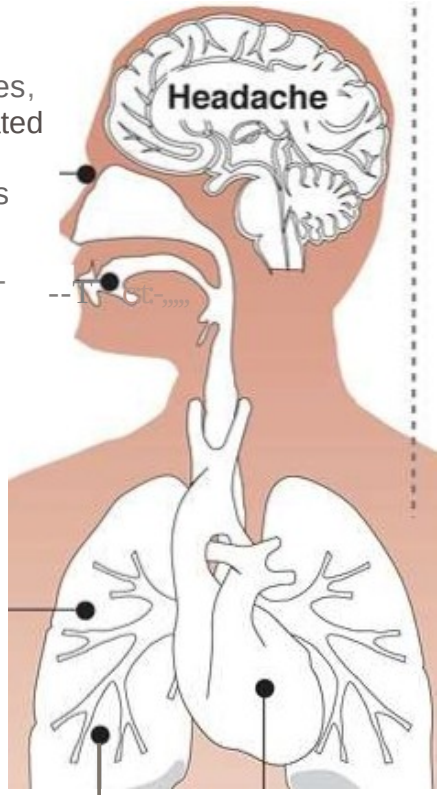
- Excessive lead exposure can cause seizures, brain and kidney damage, mental retardation, and behavioural disorders.
- Children that are 6 years of age and under are most at risk because their bodies are growing quickly
- Research suggests that the primary sources of lead exposure for most children are deteriorating lead-based paint, lead-contaminated dust, and lead-contaminated residential soil.
- Common renovation activities like sanding, cutting, demolition can create hazardous lead dust and chips by disturbing lead-based paint, which can be harmful to adults and children.

Ozone

- Ozone is a gas that forms in the atmosphere when three atoms of oxygen are combined.
- It is not emitted directly into the air but is created at ground level by a chemical reaction between oxides of nitrogen and volatile organic compounds in the presence of sunlight.
- Ozone has the same chemical structure whether it occurs high above the earth or at ground level and can be *good* or *bad*, depending on its location in the atmosphere.
- Ozone occurs in two layers of the atmosphere.
- Here, ground-level or *bad* ozone is an air pollutant that damages human health, vegetation, and many common materials.
- It is a key ingredient of urban smog.
- The stratospheric, or *good* ozone layer, extends upward from about 10 to 30 miles and protects life on earth from

Ozone, the main ingredient in smog, is one of the most widespread air pollutants and among the most dangerous.

Effects on health



Burning eyes, throat; irritated mucous membranes

Shortness of breath, - wheezing, coughing

Asthma attacks, chest pain when inhaling, increased risk of respiratory diseases

Pulmonary inflammation

Increased risk of heart attacks

Source: American Lung Association, State of the Air 2008, AP Graphic: Staff

How ozone forms

1 Oxygen in the atmosphere 

2 Nitric oxide, byproduct of combustion 

3 Sunlight breaks up nitric oxide

N **O**

4 Ozone formed by three oxygen atoms 

U.S. ozone limits

In parts per billion

• 1997-2008	**84**
• 2008-present	**75**
• New EPA proposal	**60-70**

Health Impacts of Exposure

- The reactivity of ozone causes health problems because it damages lung tissue, reduces lung function, and sensitizes the lungs to other irritants.
- Scientific evidence indicates that ambient levels of ozone not only affect people with impaired respiratory systems, such as asthmatics, but healthy adults and children as well.
- Exposure to ozone for several hours at relatively low concentrations has been found to significantly reduce lung function and induce respiratory inflammation in normal, healthy people during exercise
- This decrease in lung function generally is accompanied by symptoms including chest pain, coughing, sneezing,

Nitrogen Dioxide

- Nitrogen dioxide is a brownish, highly reactive gas present in all urban atmospheres.
- Nitrogen dioxide is a criteria pollutant that can irritate the lungs, cause bronchitis and pneumonia, and lower resistance to respiratory infections.
- Nitrogen oxides contribute to formation of both ozone and acid rain and may affect both terrestrial and aquatic ecosystems.
- The major mechanism for the formation of nitrogen dioxide in the atmosphere is the oxidation of the primary air pollutant nitric oxide
- Nitrogen oxide forms when fuel is burned at high temperatures.
- The two major emission sources of nitrogen oxides are

Health Impacts of Exposure

Health effects of exposure to nitrogen dioxide include the following:

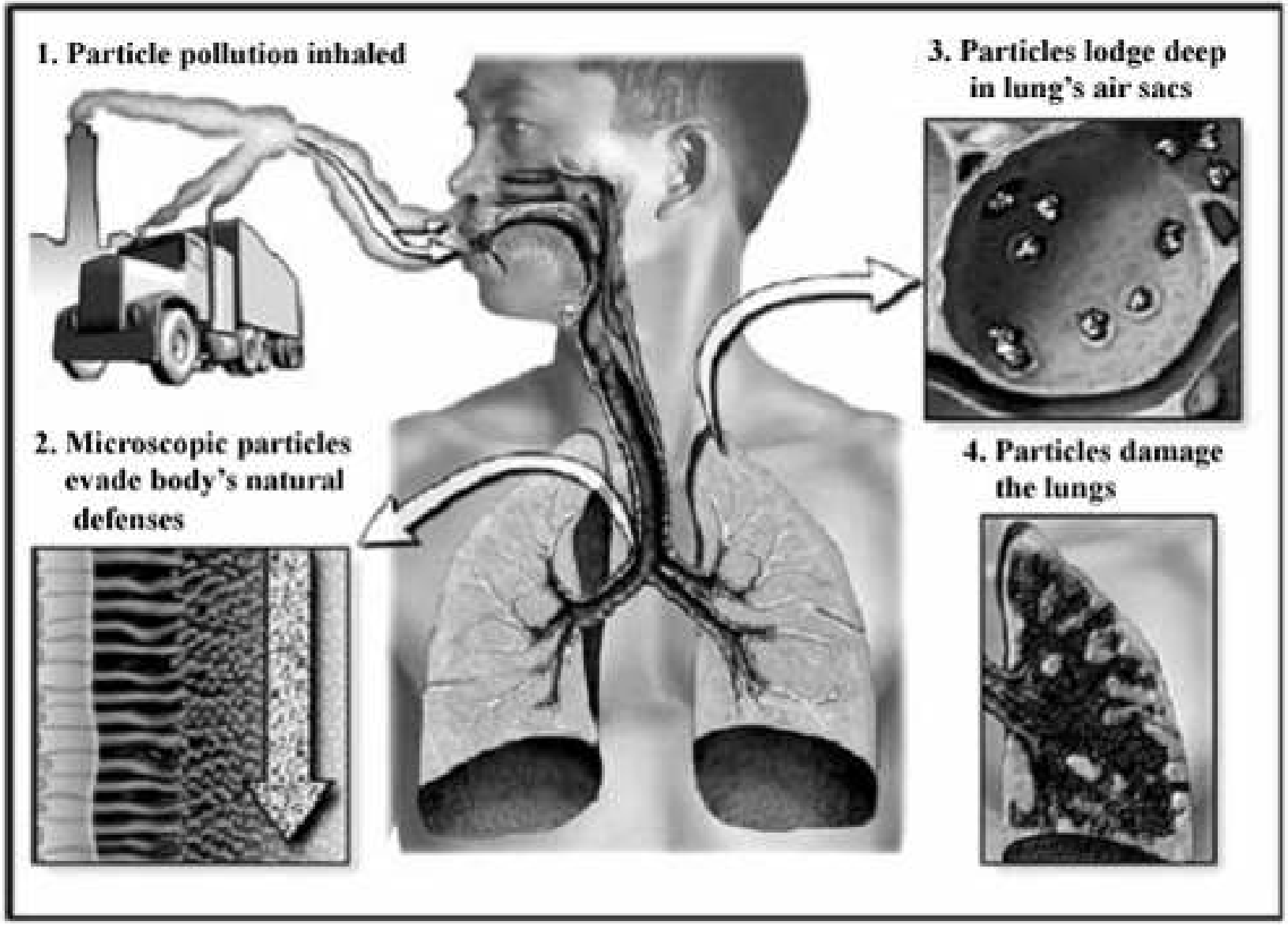
1. In children and adults with respiratory disease such as asthma, nitrogen dioxide can cause coughing, wheezing, and shortness of breath.
2. Even short exposures to nitrogen dioxide can affect lung function.
3. In children, short-term exposure can increase the risk of respiratory illness.
4. Animal studies suggest that long-term exposure to nitrogen dioxide may increase susceptibility to respiratory infection and may cause permanent structural changes in the lungs.

Particulate Matter

- Particulate matter (PM) is the term for small particles found in the air including dust, dirt, soot, smoke, and liquid droplets.
- Particles can be suspended in the air for long periods of time.
- Some particles are large or dark enough to be seen as soot or smoke. Others are so small that individually they can only be detected with an electron microscope.
- Some particles are directly emitted into the air while others are formed in the air through chemical reactions.
- Sources of PM include cars, trucks, buses, factories, construction sites, tilled fields, unpaved roads, construction, wood burning, agricultural burning, wildfires, prescribed fires, and natural windblown dust.

Particulate Matter

- Particulate matter is a criteria pollutant that comes in a wide range of sizes.
- Particles less than 10 micrometers in diameter tend to pose the greatest health concern because they can be inhaled into and accumulate in the respiratory system.
- Particles less than 2.5 micrometers in diameter are referred to as *fine* particles.
- Sources of fine particles include all types of combustion (e.g., motor vehicles, power plants, and wood burning) and some industrial processes.
- Particles with diameters between 2.5 and 10 micrometers are referred to as *coarse*. Sources of coarse particles include crushing or grinding


1. Particle pollution inhaled
3. Particles lodge deep in lung's air sacs
2. Microscopic particles evade body's natural defenses
4. Particles damage the lungs

Health Impacts of Exposure

- Both fine and coarse particles can accumulate in the respiratory system and are associated with numerous health effects.
- Coarse particles can aggravate respiratory conditions such as asthma.
- Exposure to fine particles is associated with several serious health effects, including premature death. Adverse health effects have been associated with exposures to PM over both short periods (such as a day) and longer periods (a year or more).
- When exposed to PM, people with existing heart or lung diseases such as asthma, chronic obstructive pulmonary disease, congestive heart disease, or ischemic heart disease—are at increased risk of premature death or ailments.
- When exposed to PM, children and people with existing lung disease may not be able to breathe normally and may experience symptoms such as coughing and shortness of breath.

Sulphur Dioxide

- Sulphur dioxide is a colourless, reactive gas produced during burning of sulphur-containing fuels such as coal and oil, during metal smelting, and by other industrial processes.
- Sulphur dioxide emitted to the atmosphere results largely from stationary sources such as coal and oil combustion, steel mills, refineries, pulp and paper mills, and nonferrous smelters.
- Generally, the highest concentrations of this criteria pollutant are found near large industrial sources, such as power plants and industrial boilers.


Sulphur Dioxide
Petroleum Products
Refining
In bleaching by Chlorine
Antichlor
Sulphuric Acid Sulphates, Bi-Sulphates
Chemical Industry
Bacteria Fungus in Plants
Fumigant
Refining Decolourizing
Sugar Industry
Disinfectants
Hospitals
Preservative
Wines, Meat Dry Fruits
Bleaching
Delicate Articles
Refrigerant
Household Refrigerators
Solvent
Glue

Health Impacts of Exposure

- High concentrations of sulphur dioxide affect breathing and may aggravate existing respiratory and cardiovascular disease.
- Sensitive populations include asthmatics, individuals with bronchitis or emphysema, children, and the elderly.
- Sulphur dioxide is also a primary contributor to acid rain, which causes acidification of lakes and streams and can damage trees, crops, buildings, and statues.
- In addition, sulphur compounds in the air contribute to visibility impairment in large parts of the country.
- This is especially noticeable in national parks.

WHAT IF CO_2 WAS COLOURED

FOOD FOR THOUGHT

Pollutants

- Pollutants can be classified as primary or secondary. Primary pollutants are substances that are directly emitted into the atmosphere from sources. The main
- Primary pollutants known to cause harm in high enough concentrations are the following:

1) Carbon compounds, such as CO, CO_2, CH_4, and VOCs
2) Nitrogen compounds, such as NO, N_2O, and NH_3
3) Sulphur compounds, such as H_2S and SO_2
4) Halogen compounds, such as chlorides, fluorides, and bromides

5) Particulate Matter (PM or “aerosols”), either in solid or liquid form, categorized based on the aerodynamic diameter
   a) Particles less than 100 microns, which are also called “inhalable” since they can easily enter the nose and mouth.
   b) Particles less than 10 microns (PM10, often labelled “fine” in Europe). These particles are also called “thoracic” since they can penetrate deep in the respiratory system.
   c) Particles less than 4 microns. These particles are often called “respirable” because they are small enough to pass completely through the respiratory system and enter the bloodstream.
   d) Particles less than 2.5 microns (PM2.5, labelled “fine”

- Sulphur compounds were responsible for the traditional wintertime sulphur smog in London in the mid 20th century.
- These anthropogenic pollutants have sometimes reached lethal concentrations in the atmosphere, such as during the infamous London smog.
- Secondary pollutants are not directly emitted from sources, but instead form in the atmosphere from primary pollutants (also called “precursors”).
- The main secondary pollutants known to cause harm in high enough concentrations are the following:

1. NO_2 and HNO_3 formed from NO
2. Ozone (O_3) formed from photochemical reactions of nitrogen oxides and VOCs
3. Sulphuric acid droplets formed from SO_2 and nitric acid droplets formed from NO_2

4. Sulphates and nitrates aerosols (e.g., ammonium (bi)sulphate and ammonium nitrate) formed from reactions of sulphuric acid droplets and nitric acid droplets with NH_3, respectively
5. Organic aerosols formed from VOCs in gas-to-particle reactions

- Petroleum products are responsible for a new type of “smog”, a photochemical summertime smog composed of secondary pollutants
- Photochemical smog was first recognized in the city of Los Angeles in 1940s.
- The smog was identified as the product of photochemical reactions involving “precursors (nitrogen oxides and VOC) and sunlight, with the production of ozone and other secondary chemicals.

- While nitrogen oxides are emitted by a wide variety of sources, automobiles mostly emit VOCs, even though contributions can be found from vegetation and common human activities, such as bakeries
- Some secondary pollutants – sulphates, nitrates, and organic particles – can be transported over large distances, such as hundreds and even thousands of miles
- Wet and dry deposition of these pollutants contributes to the “acid deposition” problem (often called “acid rain”), with possible damage to soils, vegetation, and susceptible lakes.

Air pollution control techniques

- Source control techniques
- Important - sets the tools to control air pollutant emissions.
- Control measurements describes the equipment, processes or actions used to reduce air pollution.
- The extent of pollution reduction varies among technologies and measures.
- The selection of control technologies depends on environmental, engineering, economic factors and

CONTROL OF PARTICULATE MATTER FROM STATIONARY SOURCES

Settling Chambers

- Settling chambers use the force of gravity to remove solid particles.
- The gas stream enters a chamber where the velocity of the gas is reduced.
- Large particles drop out of the gas and are recollected in hoppers.
- Because settling chambers are effective in removing only larger particles, they are used in conjunction with a more efficient control

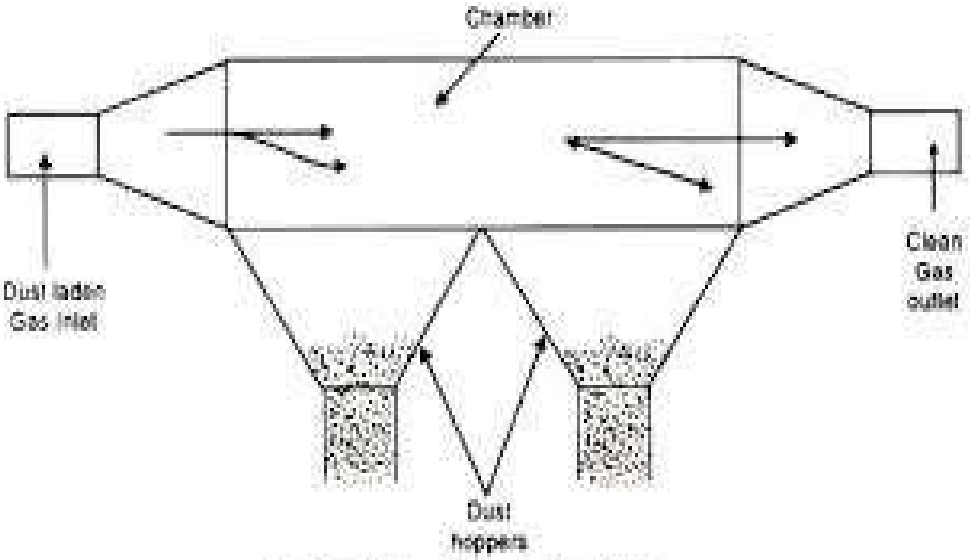
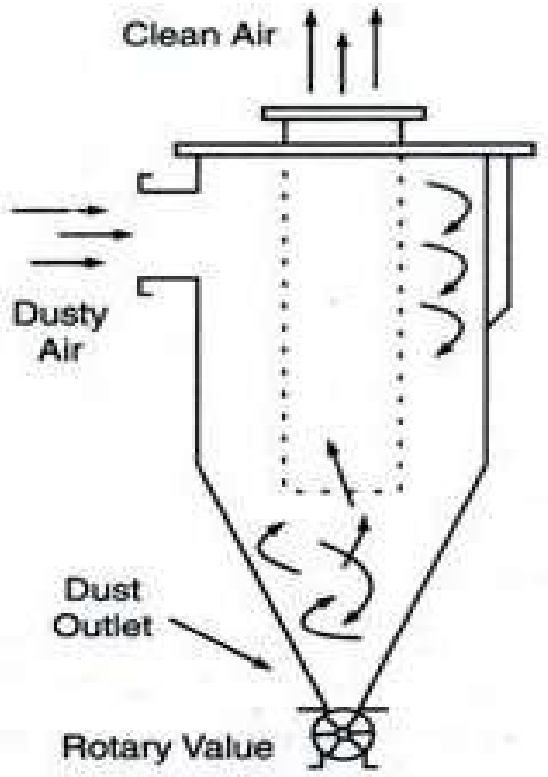


Fig. 6.4. Horizontal Flow Settling Chamber.

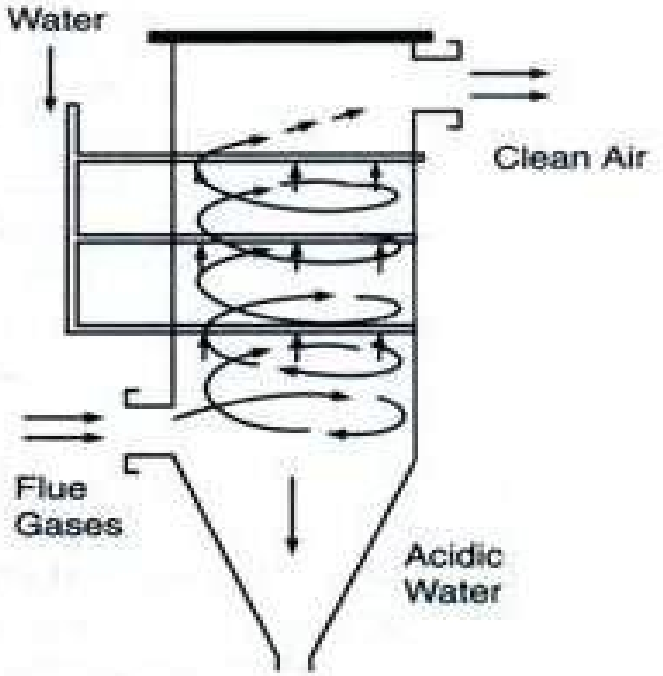
Cyclones

- The general principle of inertia separation is that the particulate-laden gas is forced to change direction.
- As gas changes direction, the inertia of the particles causes them to continue in the original direction and be separated from the gas stream.
- The walls of the cyclone narrow toward the bottom of the unit, allowing the particles to be collected in a hopper.
- The cleaner air leaves the cyclone through the top of the chamber, flowing upward in a spiral vortex, formed within a downward moving spiral.
- Cyclones are efficient in removing large particles but are not as efficient with smaller particles.
- For this reason, they are used with other particulate control devices.

Cyclones



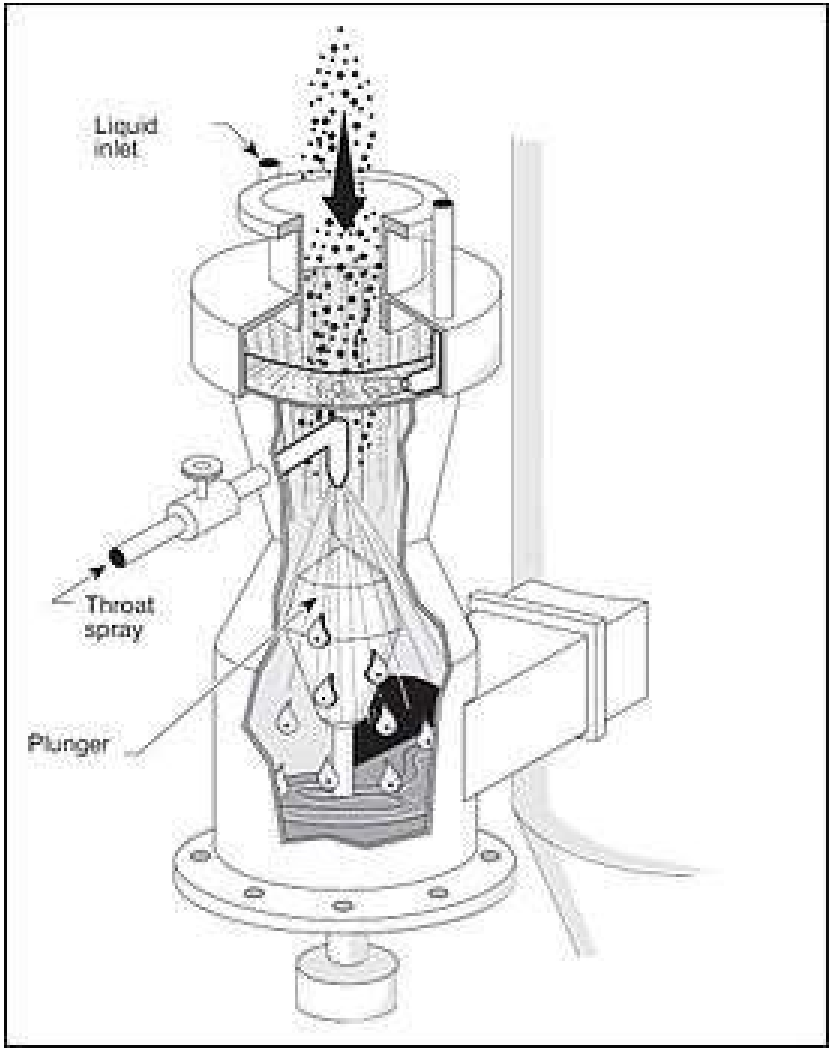
Cyclone Separator



Wet Collector

Venturi scrubbers

- Venturi scrubbers use a liquid stream to remove solid particles.
- In the venturi scrubber, gas laden with particulate matter passes through a short tube with flared ends and a constricted middle.
- This constriction causes the gas stream to speed up when the pressure is increased



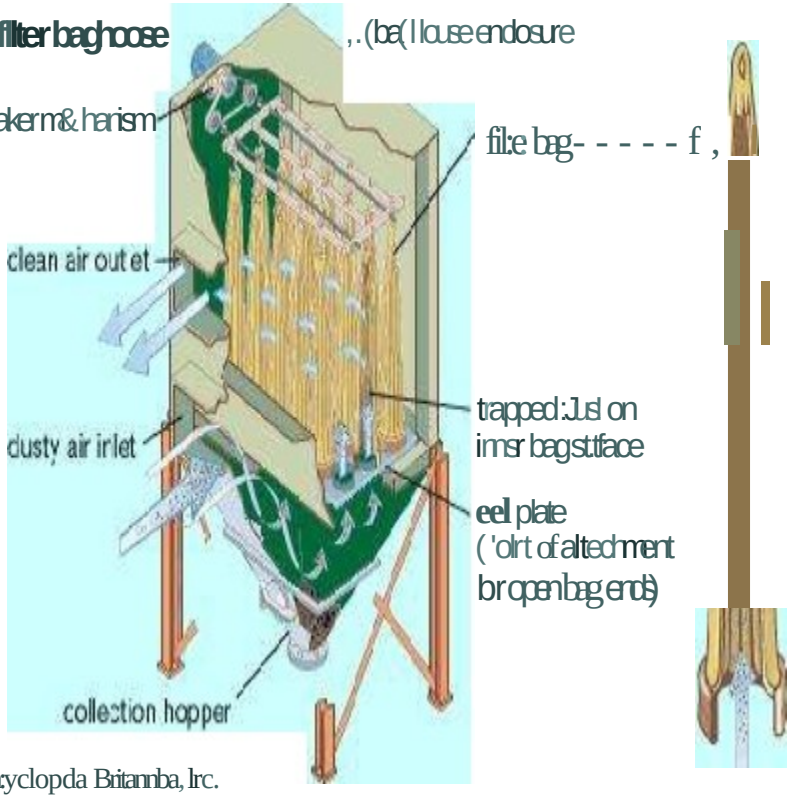
Venturi Scrubbers

- The difference in velocity and pressure resulting from the constriction causes the particles and water to mix and combine.
- The reduced velocity at the expanded section of the throat allows the droplets of water containing the particles to drop out of the gas stream.
- Venturi scrubbers are effective in removing small particles, with removal efficiencies of up to 99 percent.
- One drawback of this device, however, is the production of wastewater.

Fabric Filters or Bag houses

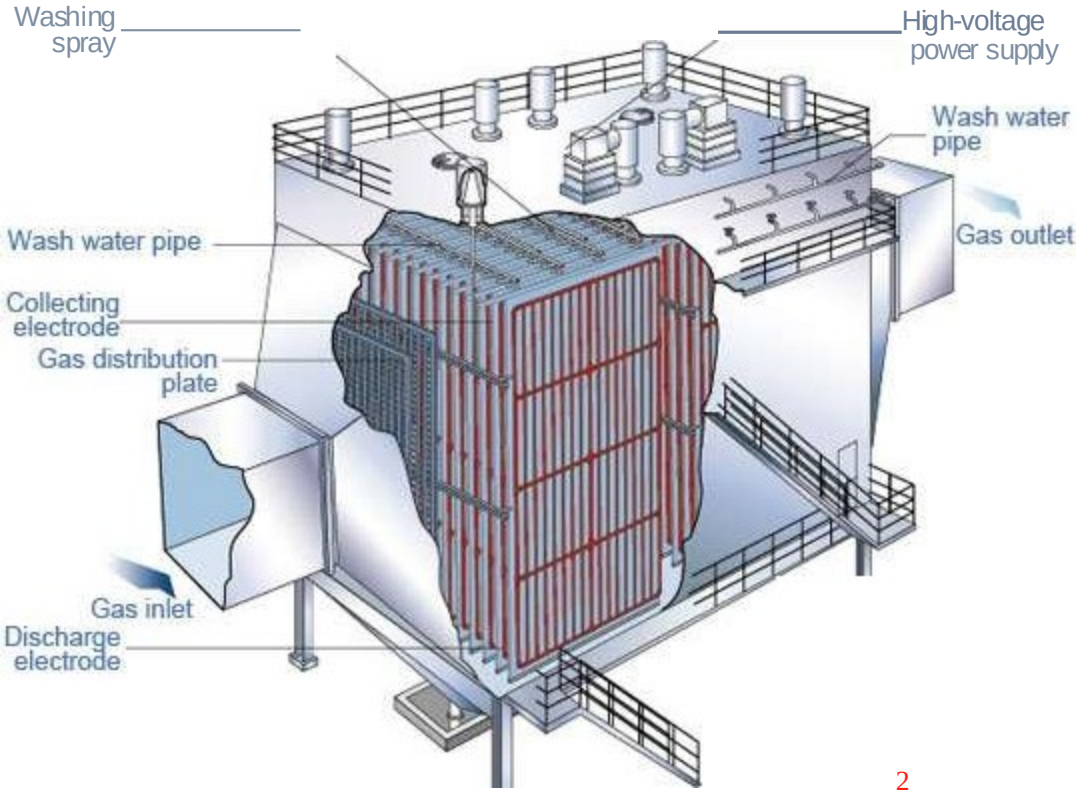
- Fabric filters, or bag houses, remove dust from a gas stream by passing the stream through a porous fabric.
- The fabric filter is efficient at removing fine particles and can exceed efficiencies of 99 percent in most applications.
- The selection of the fiber material and fabric construction is important to bag house performance.
- The fiber material from which the fabric is made must have adequate strength characteristics at the maximum gas temperature expected and adequate chemical compatibility with both the gas and the collected dust.
- One disadvantage of the fabric filter is that high-temperature gases often have to be cooled before contacting the filter medium.

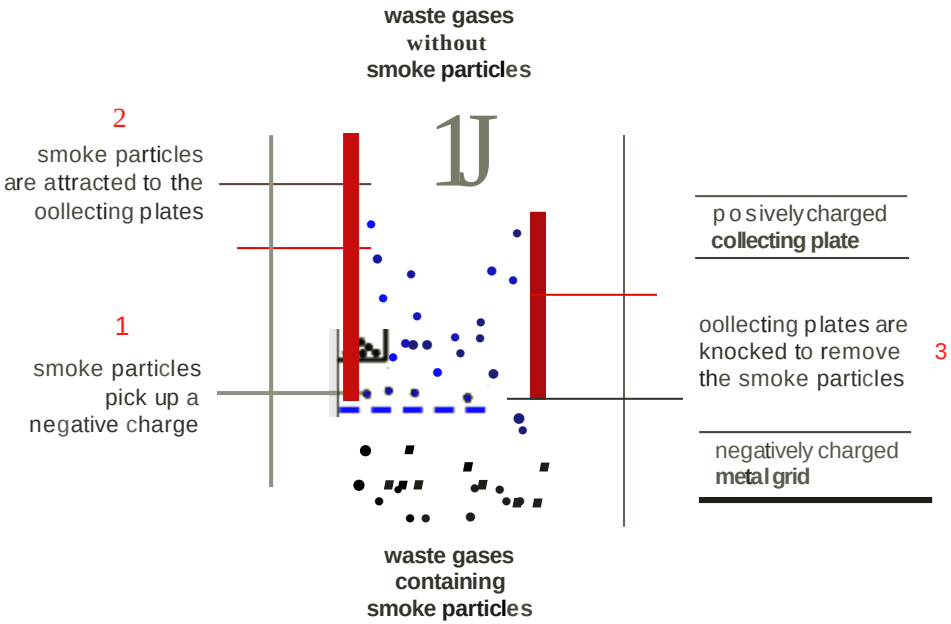
Fabric-filter baghouse



Electrostatic Precipitators (ESPs)

- An ESP is a particle control device that uses electrical forces to move the particles out of the flowing gas stream and onto collector plates
- The ESP places electrical charges on the particles, causing them to be attracted to oppositely charged metal plates located in the precipitator
- The particles are removed from the plates by "rapping" and collected in a hopper located below the unit.
- The removal efficiencies for ESPs are highly variable; however, for very small particles alone, the removal efficiency is about 99 percent.
- Electrostatic precipitators are not only used in utility applications but also other industries (for other exhaust gas particles) such as cement (dust), pulp & paper (salt cake & lime dust), petrochemicals (sulfuric acid mist), and


Washing spray
High-voltage power supply
Wash water pipe
Gas outlet
Wash water pipe
Collecting electrode
Gas distribution plate
Gas inlet
Discharge electrode

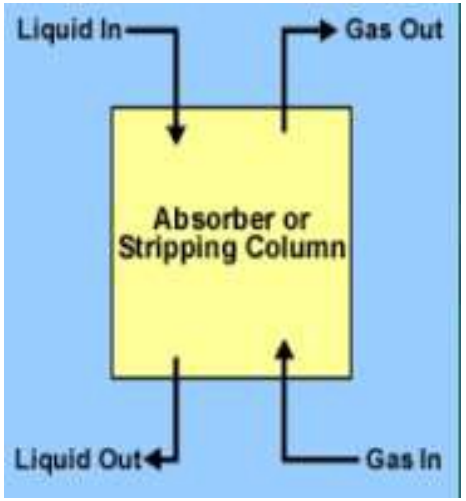

waste gases without smoke particles
2
smoke particles are attracted to the oollecting plates
1
smoke particles pick up a negative charge
p o sively charged collecting plate
oollecting plates are knocked to remove the smoke particles
3
negatively charged metal grid
waste gases containing smoke particles

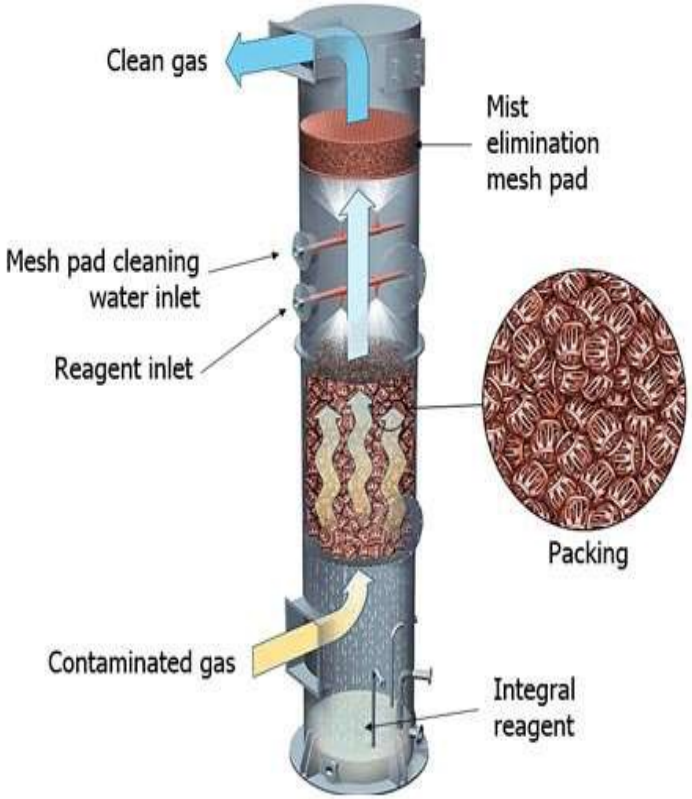
Control of gaseous pollutants from stationary sources

- The most common method for controlling gaseous pollutants is the addition of add-on control devices to recover or destroy a pollutant.
- There are four commonly used control technologies for gaseous pollutants:
  - Absorption,
  - Adsorption,
  - Condensation, and
  - Incineration (combustion)

Absorption

- The removal of one or more selected components from a gas mixture by absorption is probably the most important operation in the control of gaseous pollutant emissions.
- Absorption is a process in which a gaseous pollutant is dissolved in a liquid.
- Water is the most commonly used absorbent liquid.
- As the gas stream passes through the liquid, the liquid absorbs the gas, in much the same way that sugar is absorbed in a



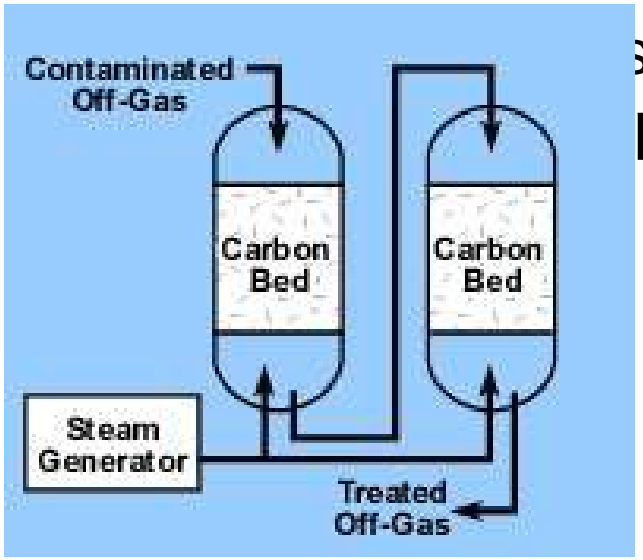


- Absorbers are often referred to as scrubbers, and there are various types of absorption equipment.
- The principal types of gas absorption equipment include spray towers, packed columns, spray chambers, and venture scrubbers.
- In general, absorbers can achieve removal efficiencies grater than 95 percent.
- One potential problem with absorption is the generation of waste-water, which converts an air pollution problem to a water pollution problem.

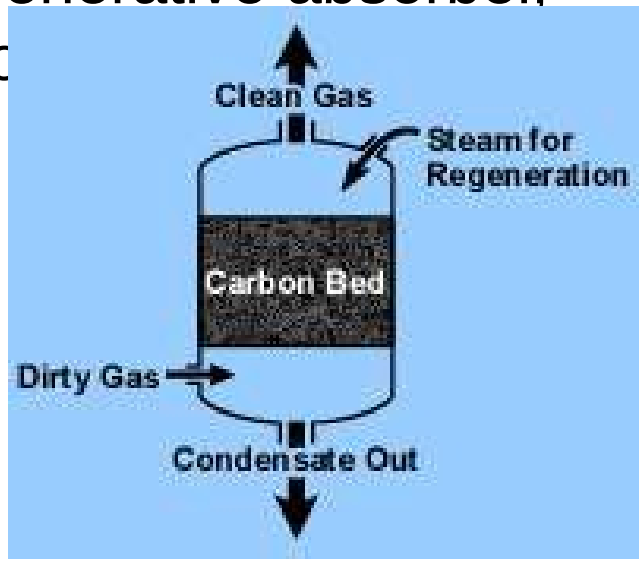
Adsorption

- When a gas or vapor is brought into contact with a solid, part of it is taken up by the solid.
- The molecules that disappear from the gas either enter the inside of the solid, or remain on the outside attached to the surface.
- The former phenomenon is termed absorption (or dissolution) and the latter adsorption.
- The most common industrial adsorbents are activated carbon, silica gel, and alumina, because they have enormous surface areas per unit weight.
- Activated carbon is the universal standard for purification and removal of trace organic contaminants from liquid and vapor streams.

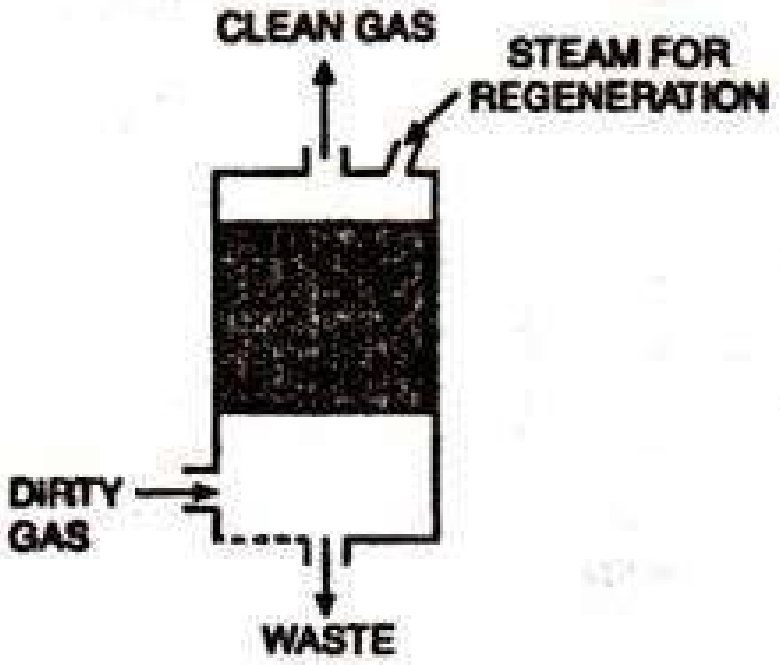
- Carbon adsorption systems are either regenerative or non-regenerative.
  - **Regenerative system** usually contains more than one carbon bed. As one bed actively removes pollutants, another bed is being regenerated for future use.
  - **Non-regenerative systems** have thinner beds of activated carbon. In a non-regenerative absorber, s disposed c pollutant.

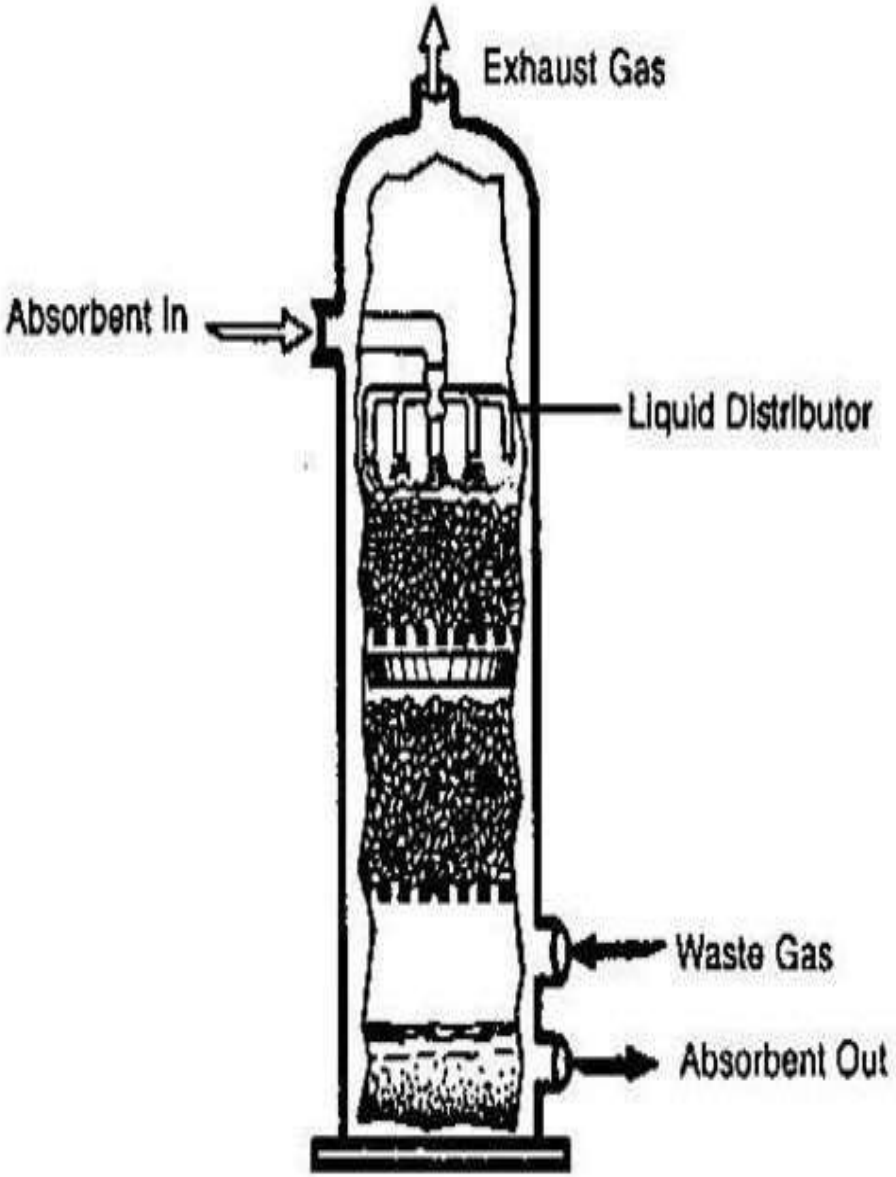


Regenerative Carbon Adsorption System



Non-Regenerative Carbon Adsorption System

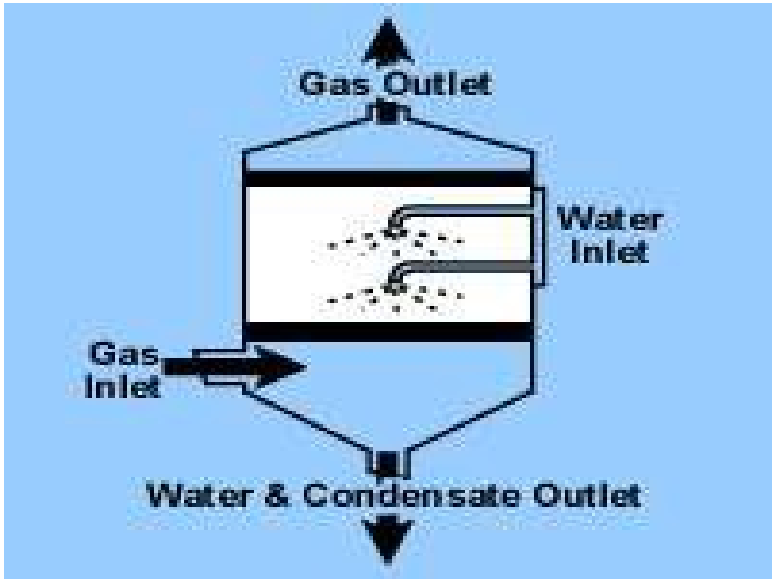

CLEAN GAS
STEAM FOR REGENERATION
DIRTY GAS
WASTE


Exhaust Gas
Absorbent In
Liquid Distributor
Waste Gas
Absorbent Out

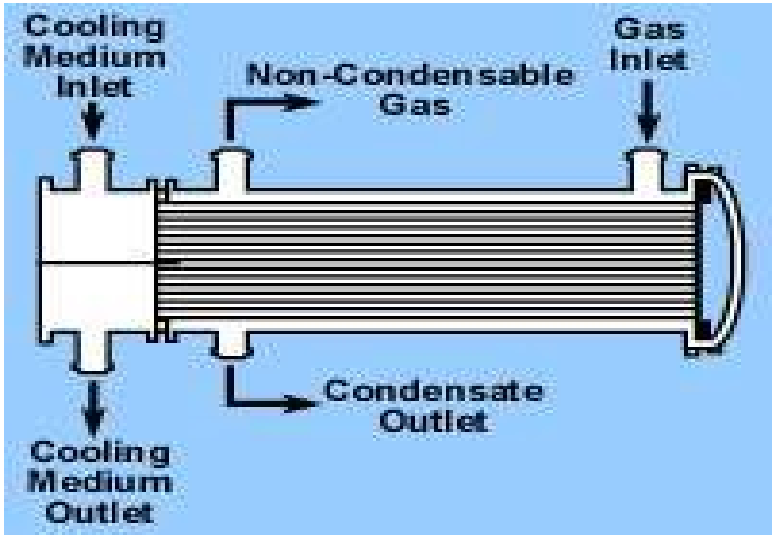
Condensation

- Condensation is the process of converting a gas or vapor to liquid.
- Any gas can be reduced to a liquid by lowering its temperature and/or increasing its pressure.
- Condensers are typically used as pretreatment devices.
- They can be used ahead of absorbers, absorbers, and incinerators to reduce the total gas volume to be treated by more expensive control equipment.
- Condensers used for pollution control are contact condensers and surface condensers.

- **In a contact condenser**, the gas comes into contact with cold liquid.
- In a **surface condenser**, the gas contacts a cooled surface in which cooled liquid or gas is circulated, such as the outside of the tube.
- Removal efficiencies of condensers typically range from 50 percent to more than 95 percent, depending on



Contact condenser



Surface condenser

Incineration

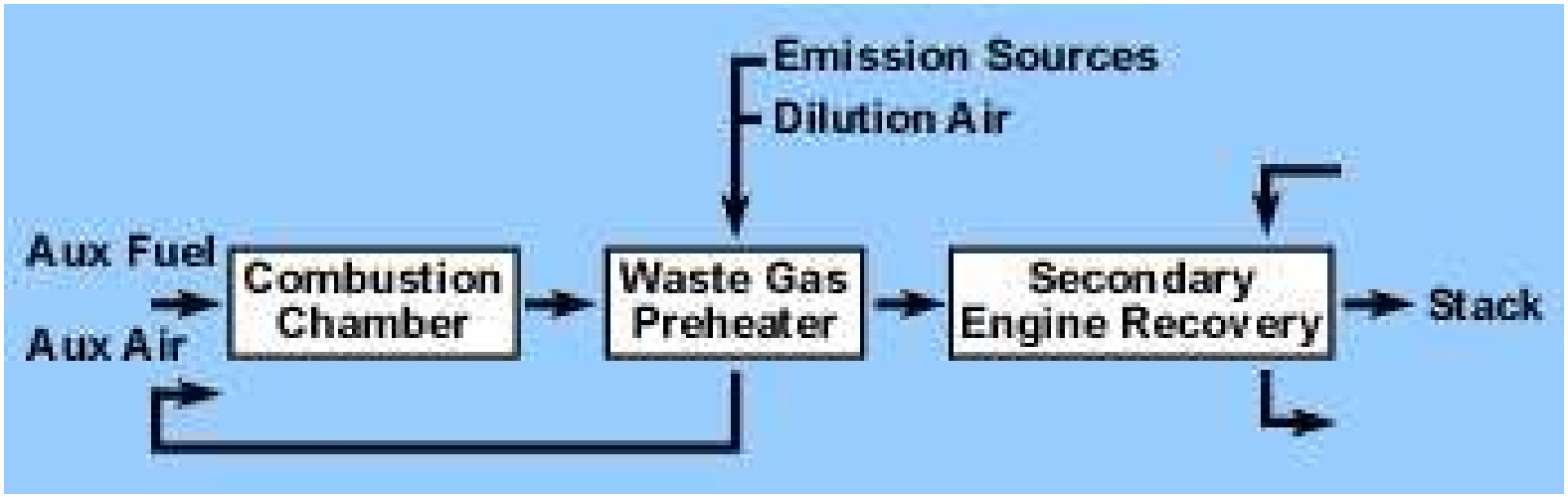
- Incineration, also known as combustion, is most used to control the emissions of organic compounds from process industries.
- This control technique refers to the rapid oxidation of a substance through the combination of oxygen with a combustible material in the presence of heat.
- When combustion is complete, the gaseous stream is converted to carbon dioxide and water vapor.
- Equipment used to control waste gases by combustion can be divided in three categories:
  - Direct combustion or flaring,
  - Thermal incineration and
  - Catalytic incineration.

Direct Combustion

- **Direct combustor** is a device in which air and all the combustible waste gases react at the burner.
- Complete combustion must occur instantaneously since there is no residence chamber.
- A flare can be used to control almost any emission stream containing volatile organic compounds.
- Studies conducted by EPA have shown that the destruction efficiency of a flare is about 98 percent.

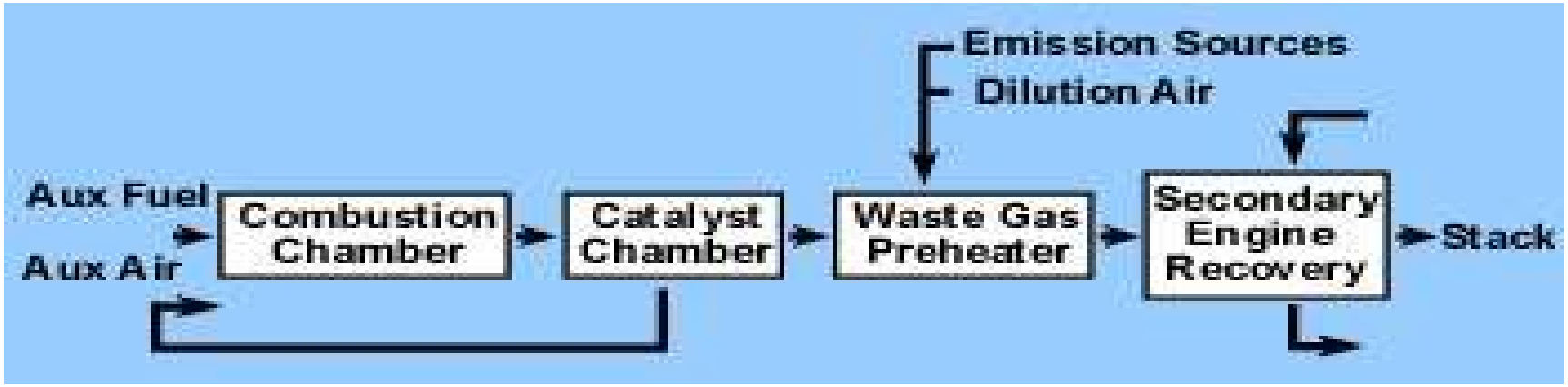
Thermal incineration

- In **thermal incinerators** the combustible waste gases pass over or around a burner flame into a residence chamber where oxidation of the waste gases is completed.
- Thermal incinerators can destroy gaseous pollutants at efficiencies of greater than 99



Thermal incinerator general case

- **Catalytic incinerators** are very similar to thermal incinerators.
- The main difference is that after passing through the flame area, the gases pass over a catalyst bed
- A catalyst promotes oxidation at lower temperatures, thereby reducing fuel costs.
- Destruction efficiencies greater than 95 percent are possible using a catalytic incinerator.

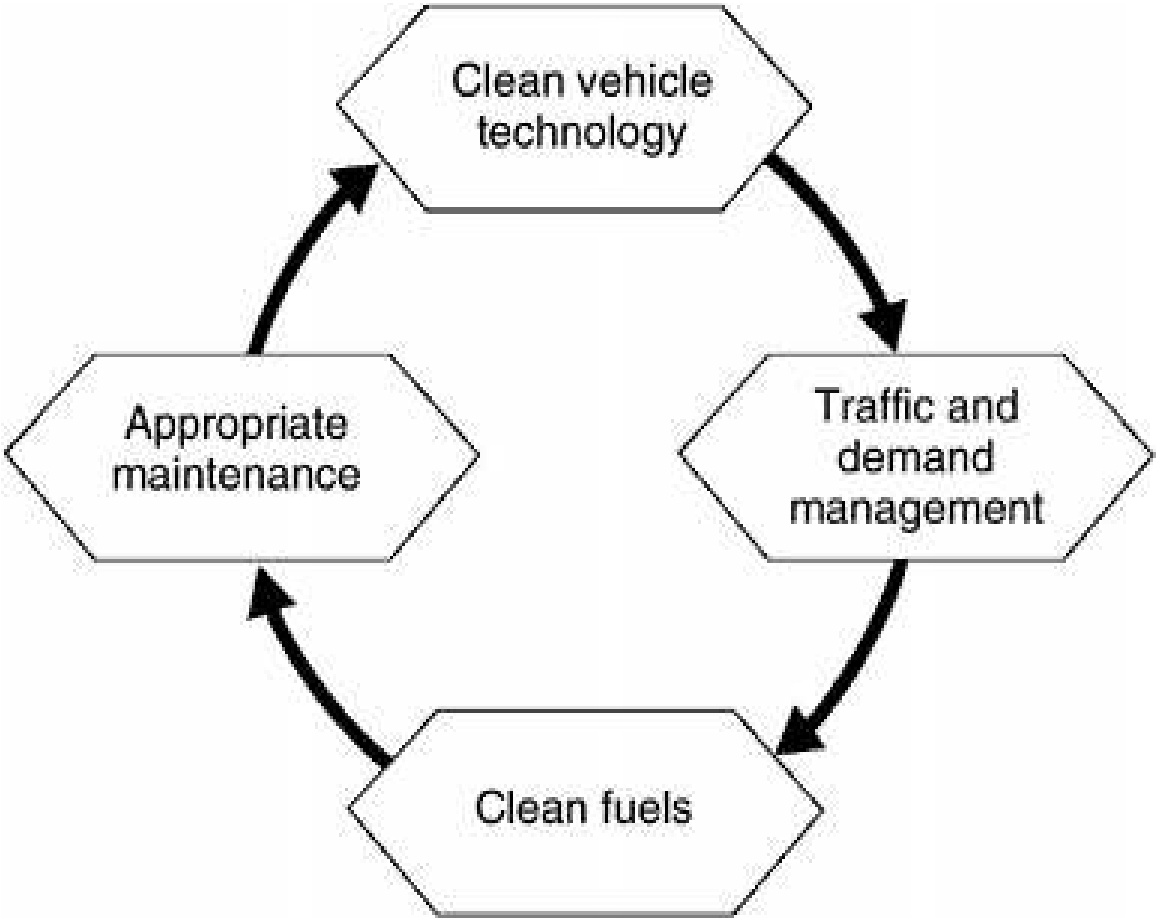


Catalytic incinerator

Controlling Air Pollution from Motor Vehicles

- Motor vehicles are significant sources of pollution that can damage the environment and pose public health issues. Everyone has a stake in limiting pollution.

Elements of a comprehensive vehicle pollution control strategy



How Vehicle Pollution Harms the Environment and Health

- Carbon monoxide, nitrogen oxides, and hydrocarbons are released when fuel is burned in an internal combustion engine and when air/fuel residuals are emitted through the vehicle tailpipe.
- Gasoline vapours also escape into the atmosphere during refuelling and when fuel vaporizes from engines and fuel systems caused by vehicle operation or hot weather.
- The pollutants in vehicle emissions are known to damage lung tissue, and can lead to and aggravate respiratory diseases, such as asthma. Motor vehicle pollution also contributes to the formation of acid rain and adds to the greenhouse gases that cause climate

- Pollutants emitted directly from vehicles are not the only cause for concern. On warm, sunny days, hydrocarbons react with oxides of nitrogen to create a secondary pollutant, ozone.
- In many urban areas, motor vehicles are the single largest contributor to ground-level ozone which is a common component of smog.
- Ozone causes coughing, wheezing and shortness of breath, and can bring on permanent lung damage, making it a cause of crucial public health problems.

Zero-Emission Vehicles

- Zero-emission vehicles include battery-electric vehicles, plug-in hybrid-electric vehicles, and hydrogen fuel-cell-electric vehicles. These technologies can be used in passenger cars, trucks and transit buses.
- New York and seven other states joined together in an initiative to put 3.3 million zero-emission vehicles on the road by 2025.
- A Memorandum of Understanding outlines the steps these states will take to expand consumer awareness and demand for zero-emission vehicles.

Reducing Vehicle Pollution

- Proper maintenance of car and truck emission control systems not only limits harmful emissions, but also can improve fuel efficiency and vehicle performance extending the life of the vehicle.
- Care in storing and handling gasoline and other solvents also reduces evaporative losses to the atmosphere.
- New York's motor vehicle Inspection and Maintenance (I/M) programs are administered by the New York State Departments of Environmental Conservation

- I/M programs require annual emissions inspections and, when necessary, require repair of faulty emission systems.
- The New York Vehicle Inspection Program is an important component of New York's State Implementation Plan to meet the national ambient air quality standard for ozone.

Be a part of air pollution reduction drive

Mother earth is choking so are we!!

THANK YOU